A CAHNERS PUBLICATION INTERNATIONAL EDITION JULY 9, 1987

27 AUG RECD

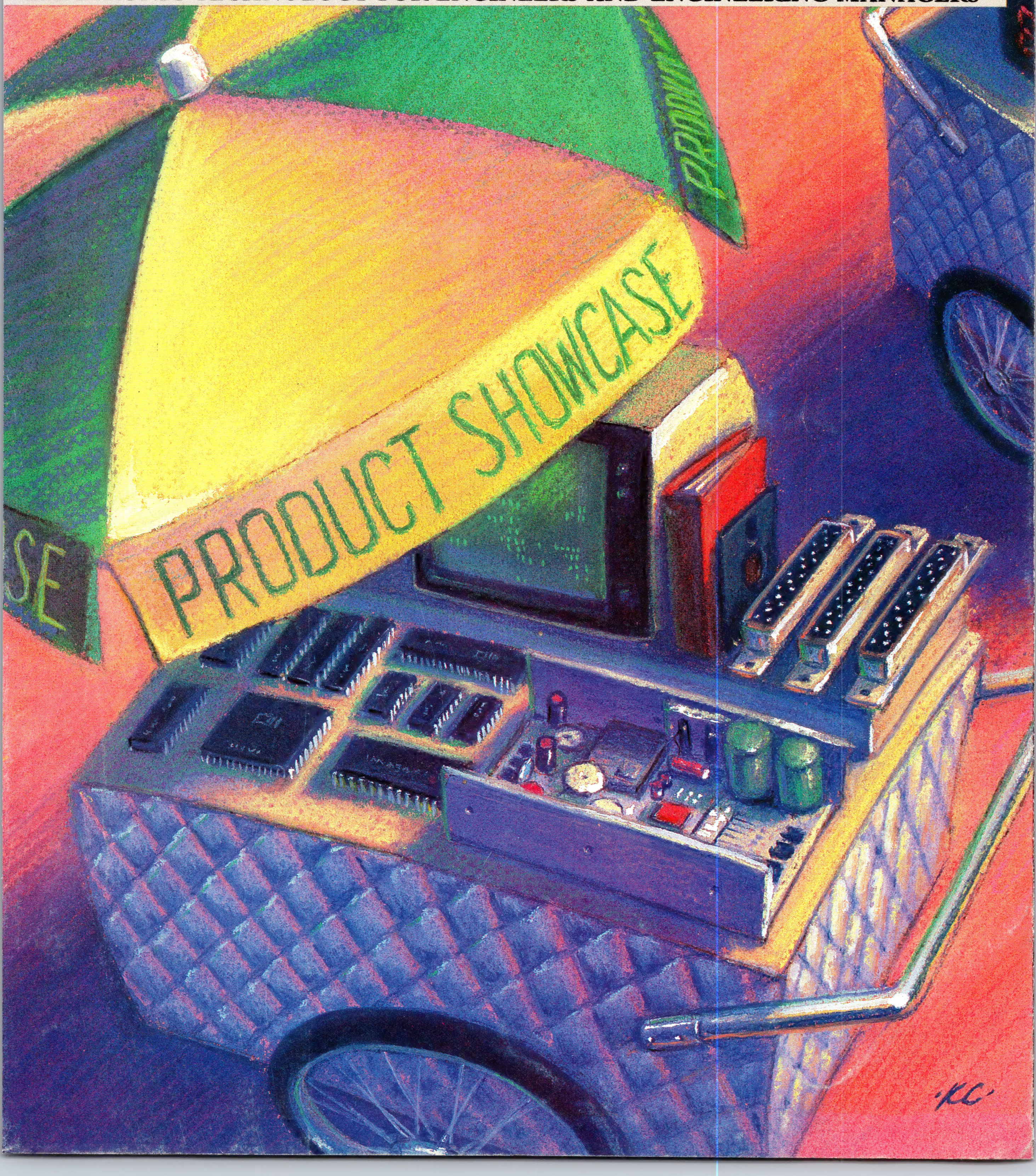
EDN®

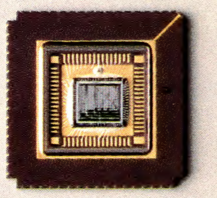
SPECIAL ISSUE—Part 1
Product Showcase No 25

Highlighting key trends in power sources, software, integrated circuits, and hardware and interconnects

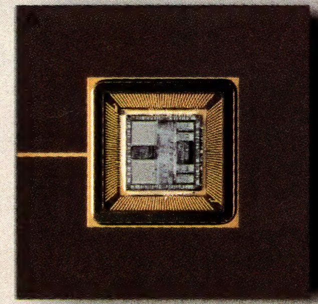
Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

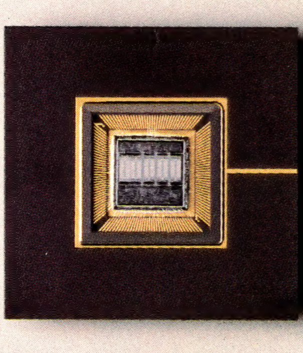




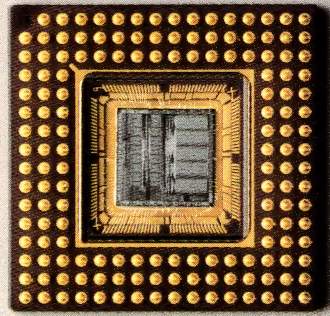
Our MACGEN silicon compiler developed the world's fastest 16-bit multiplier accumulator.



High Performance cell-based 1750 CPU combines logic, ROM and processors.



Structured Arrays combine high-density memories with up to 41,000 logic gates.



Channel-free Compacted Arrays combine logic and memory functions with up to 129,000 available (up to 70,000 utilized) gates.

If your system design looks good on a board, think how impressive it's going to look on a single chip.

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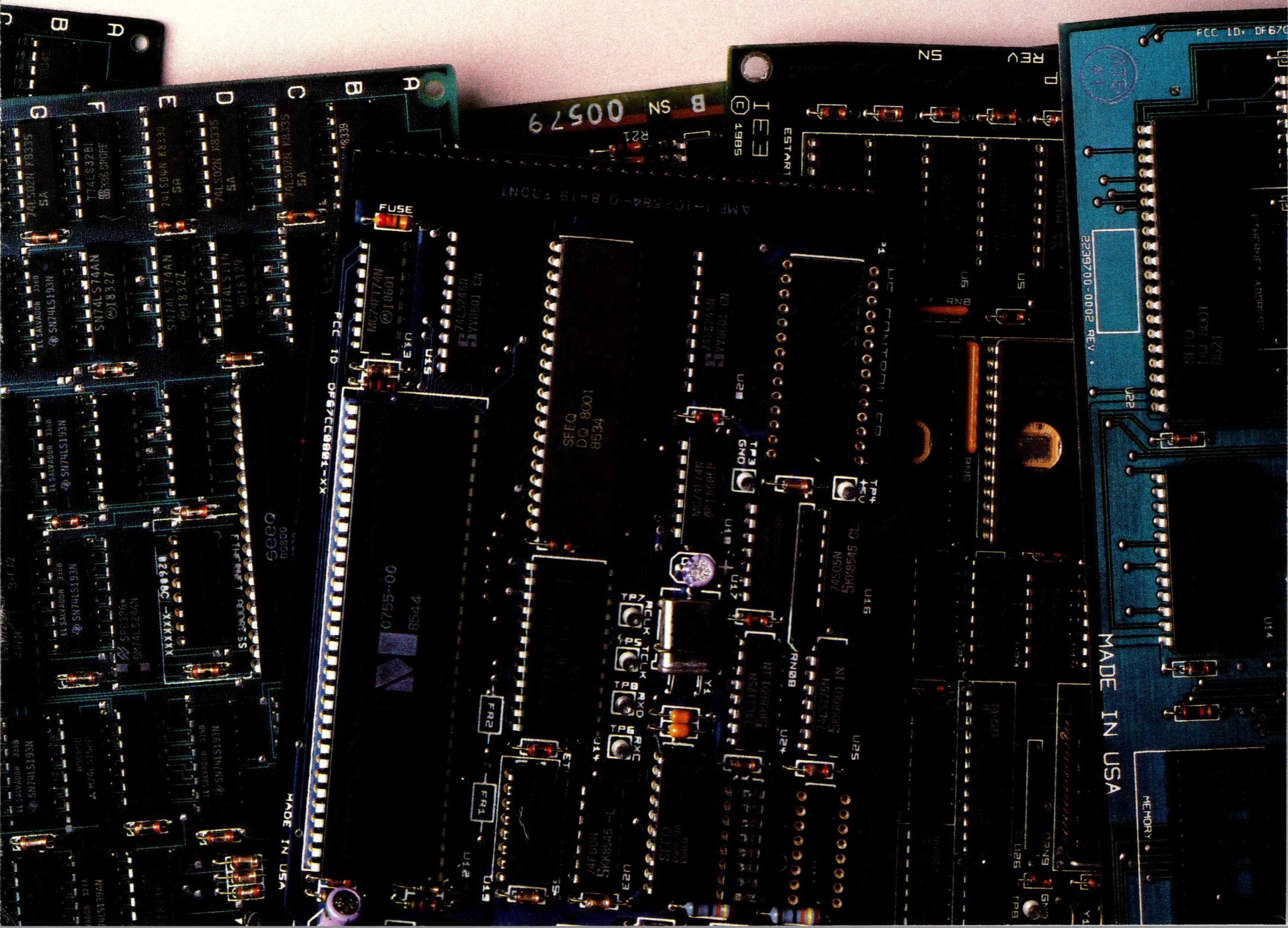
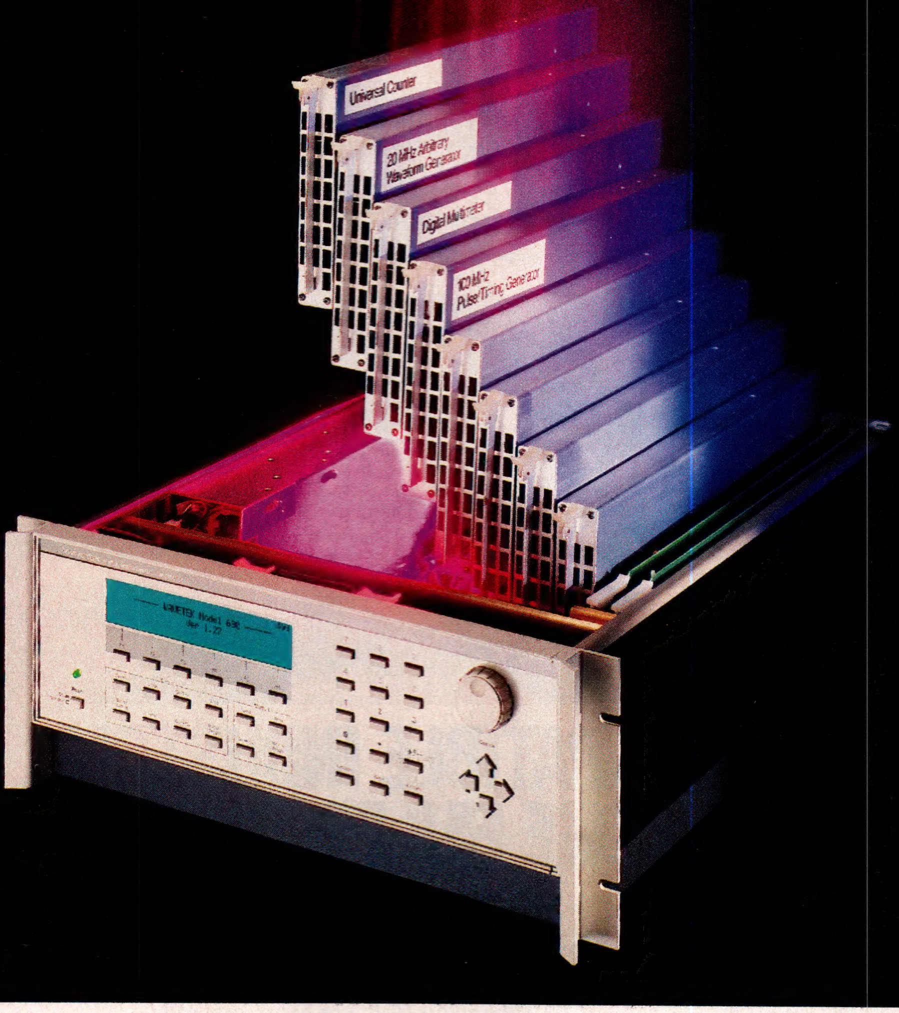
HOW TO AVOID GOING OVERBOARD.

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20 MHz Arbitrary Waveform Generator
Digital Multimeter
100 MHz Pulse/Timing Generator
WAVETEK Model 680
Ver 1.22

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Circle **103** for literature

Circle **183** for demonstration

WAVETEK

```
TYPFILE1.ASM
CAPABILITIES
  o  32 concurrently executing tasks
  o  System primitives permit implementation of semap
     gateways
  o  Scheduling and intertask coordination primitives
  o  Full preemptive, time sharing and real-time kern

DOS
  o  Executes all DOS system calls without fear of re
```

```
PARALLEL.ASM
Inpt Bit
76543210
        Port 0
        Port 1
        Port 2
        Port 3
        Port 4
        Port 5
        Port 6
        Port 7
```

```
SERIAL.ASM
IKDFW
```

```
PAX Demonstration System
(C) 1986 Baker & Rabinowitz, Inc

Type any key to return to DOS
```

```
  o  Executes all DOS system calls wi
  o  Ordered gateway to DOS enforces
     prioritization

TOOLS
  o  High performance monochrome/colo
  o  Interrupt-driven asynchronous se
  o  Keyboard, printer, parallel I/O
  o  Interrupt-vector management tool
     NOTE:  All tools come complete w
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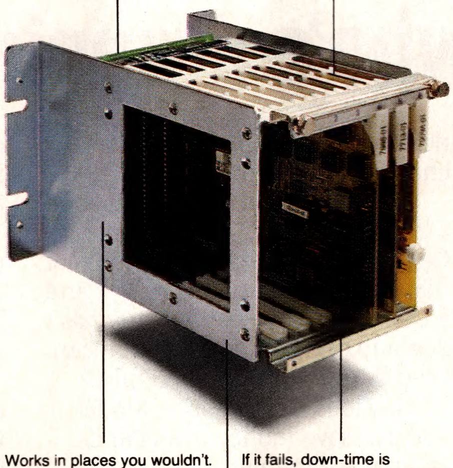

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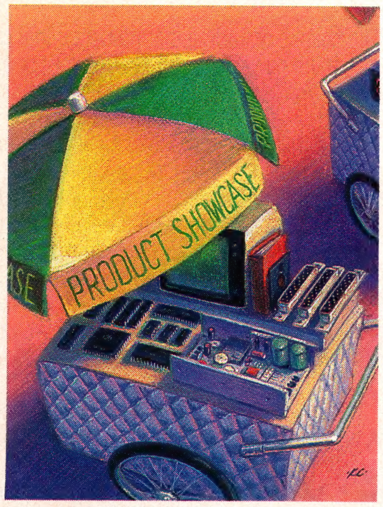
July 9, 1987

EDN

Volume 32, Number 14

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



On the cover: *Part 1 of Product Showcase No 25 describes vendors' offerings in four product categories: ICs, software, hardware and interconnect devices, and power sources. Leading off the product sections are in-depth looks at switching power-supply ICs (pg 94), graphics-interface standards (pg 166), prototype panels (pg 194), and batteries that withstand high temperatures (pg 232). (Art Direction by Kathleen Ruhl, Illustration by Ken Condon)*

DESIGN FEATURES

EDN's Hands-On SMT Project—Part 4 75

The fabricated pc boards arrived from the fabricator, and we departed for Texas to build our first SMT assemblies. There we ran into more "islands of automation," but our boards turned out to be relatively easy to assemble.—*Steven H Leibson, Regional Editor*

Integrated Circuits

Switch-mode power-supply ICs extend performance boundaries 94

A new generation of switching-control circuits is changing the way designers address switch-mode power-supply regulation. Devices for implementing voltage-mode, current-mode, and resonant-mode control can improve performance, operate at higher frequencies, and simplify control circuitry.—*Dave Pryce, Associate Editor*

Software

Device-independent interfaces enhance graphics compatibility 166

If you write application software for engineering workstations, or if you're just trying to match application software to graphics hardware, you'll be glad to know that graphics-interface standards offer freedom from device-dependent interface constraints.—*Margery S Conner, Regional Editor*

Hardware and Interconnect Devices

Dedicated prototype panels simplify bus interfacing tasks 194

Wire-wrapping panels designed to interface with specific bus structures can speed up a product's development time by significantly reducing the prototyping phase of the design cycle.—*Tom Ormond, Senior Editor*

Power Sources

Batteries function in high-temperature environments 232

You can now choose from a variety of battery chemistries that can extend the operating-temperature range of battery-powered equipment to well above 100°C. By employing solid-state materials, some of these batteries can operate at 200°C without risk of venting or explosion.—*Peter Harold, European Editor*

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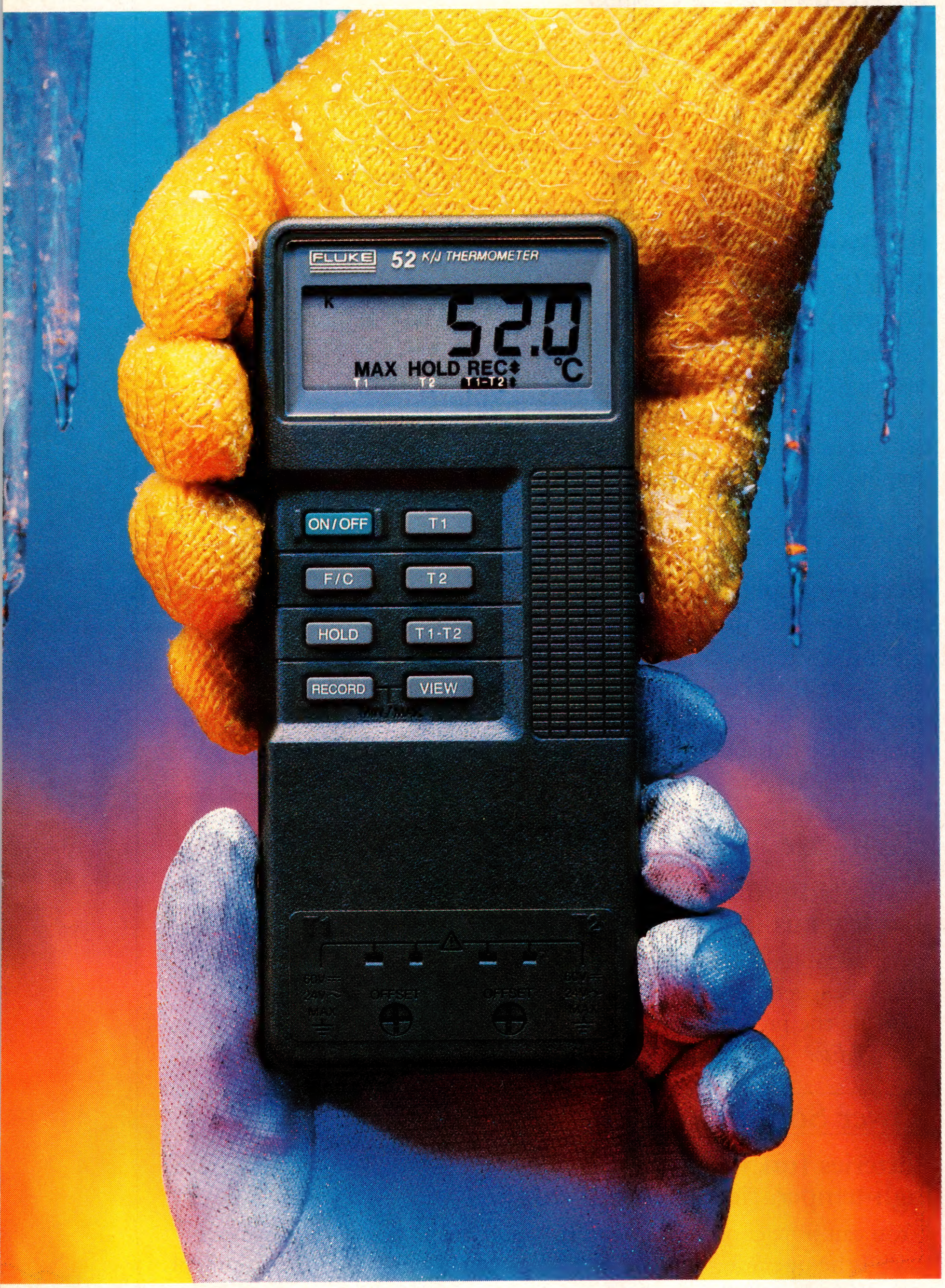
Why these new handheld thermometers give the competition chills.



The chance of finding thermometers that can match the new **Fluke 50 Series** for price and performance is like finding snowballs in August — slim to none.

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Fluke 52 Dual Input

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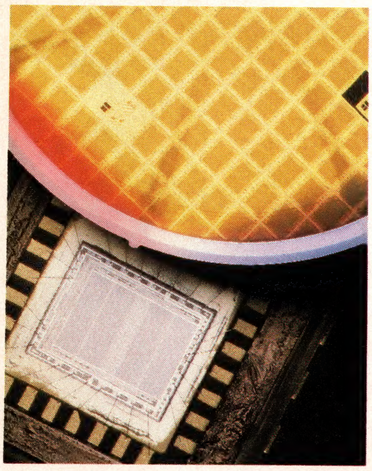
July 9, 1987



***Product coverage** in this showcase issue begins with a review of innovative integrated circuits (pg 107). Coverage continues with reviews of software (pg 176), hardware and interconnect devices (pg 206), and power sources (pg 241).*

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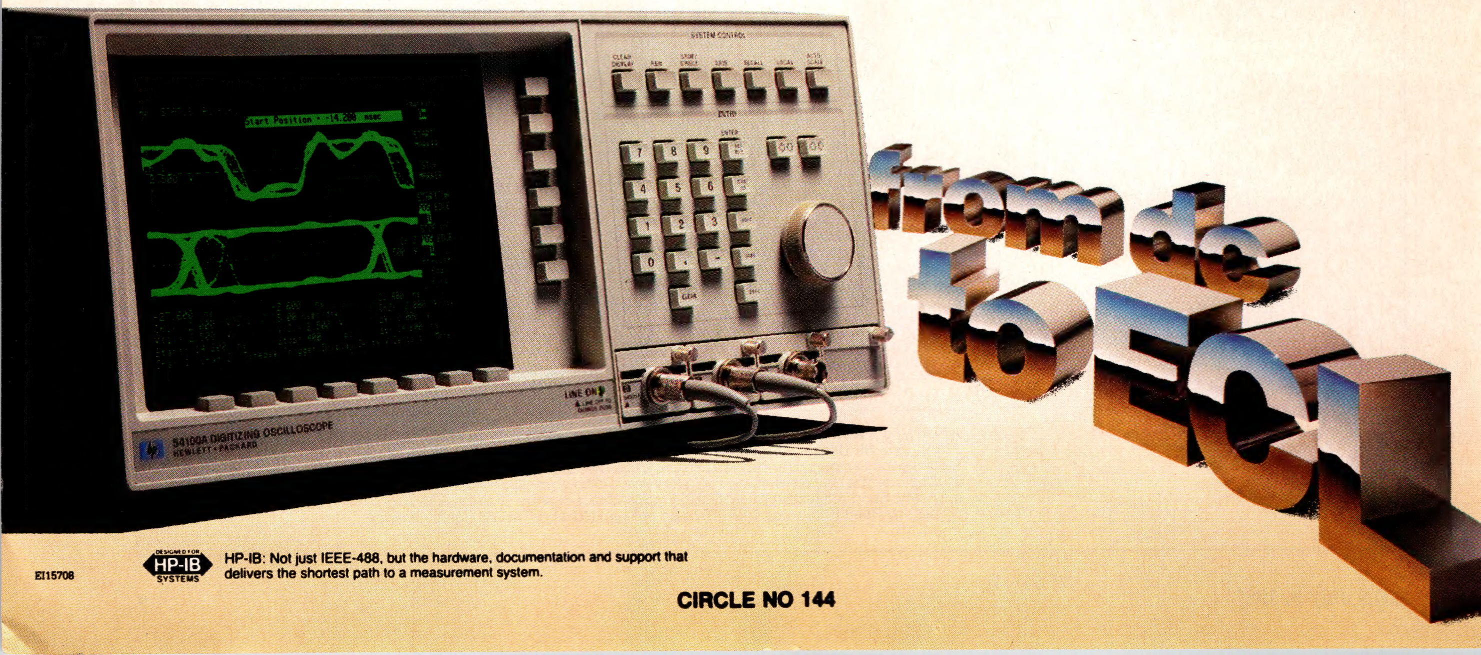

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DESIGNED FOR HP-IB SYSTEMS HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

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EDN

July 9, 1987

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Recent events show that effective military action doesn't always depend on high technology.

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Laser and F-O test-equipment market to grow at 14.4% rate. . . $1.5B sales of US relays predicted by 1991.

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A product-oriented design aid

To save you time in your efforts to keep current, EDN's editors have surveyed the new-product offerings from thousands of companies, screening and selecting only the most significant of those offerings introduced in the last six months. We present our findings—the best of the best—in a format devised to make your product selection as easy as possible. You can keep this Product Showcase as a reference until the next one that covers these four key product areas appears in December.

EDN's Professional Issues section will return next issue.

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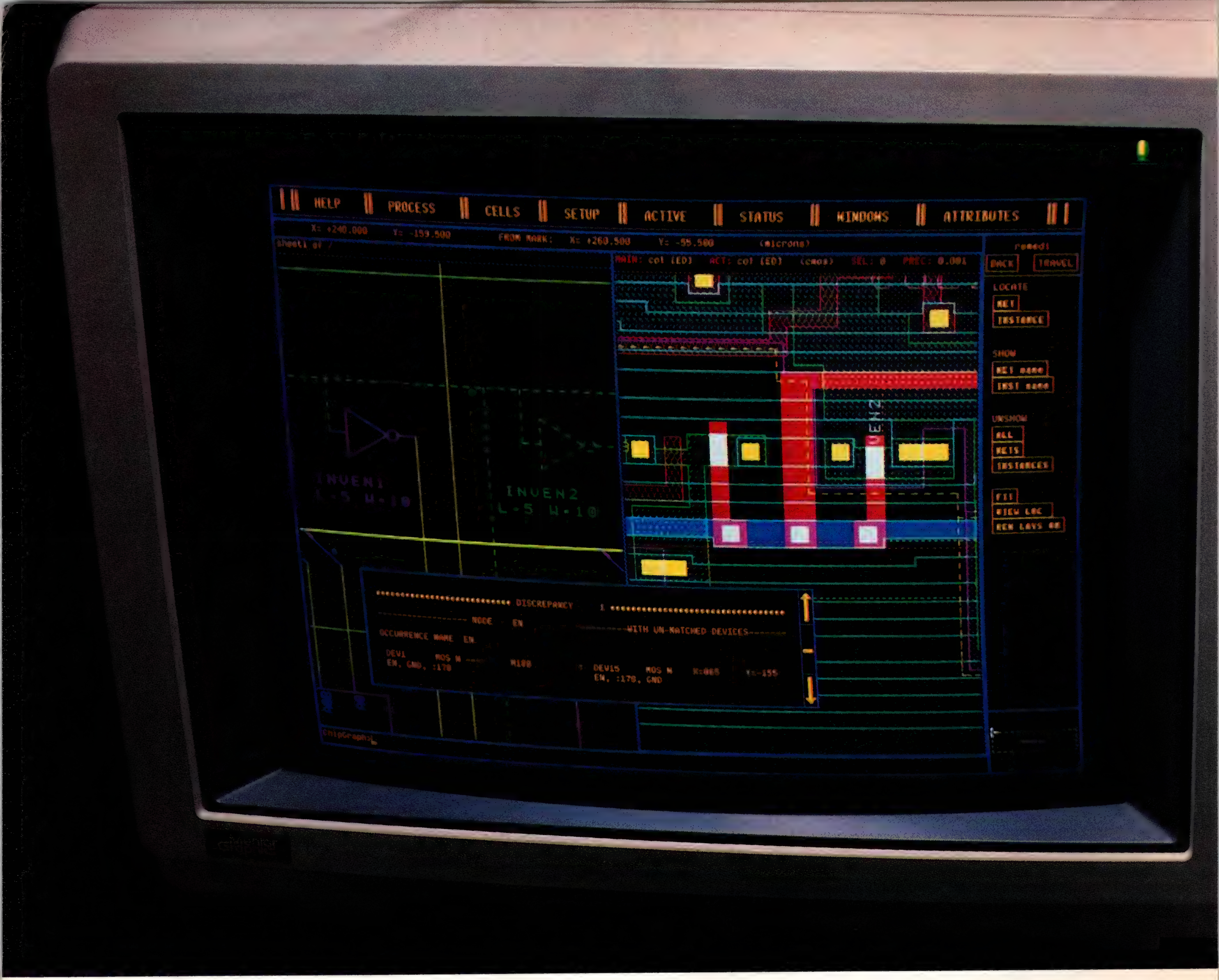

Only Mentor Graphics maps symbols to silicon.

The bigger the IC design, the bigger the problem: you're trying to locate a discrepancy between the schematic and your IC layout, but all you have is an ASCII error report. It's like driving all over a strange city to find an address — without a map.

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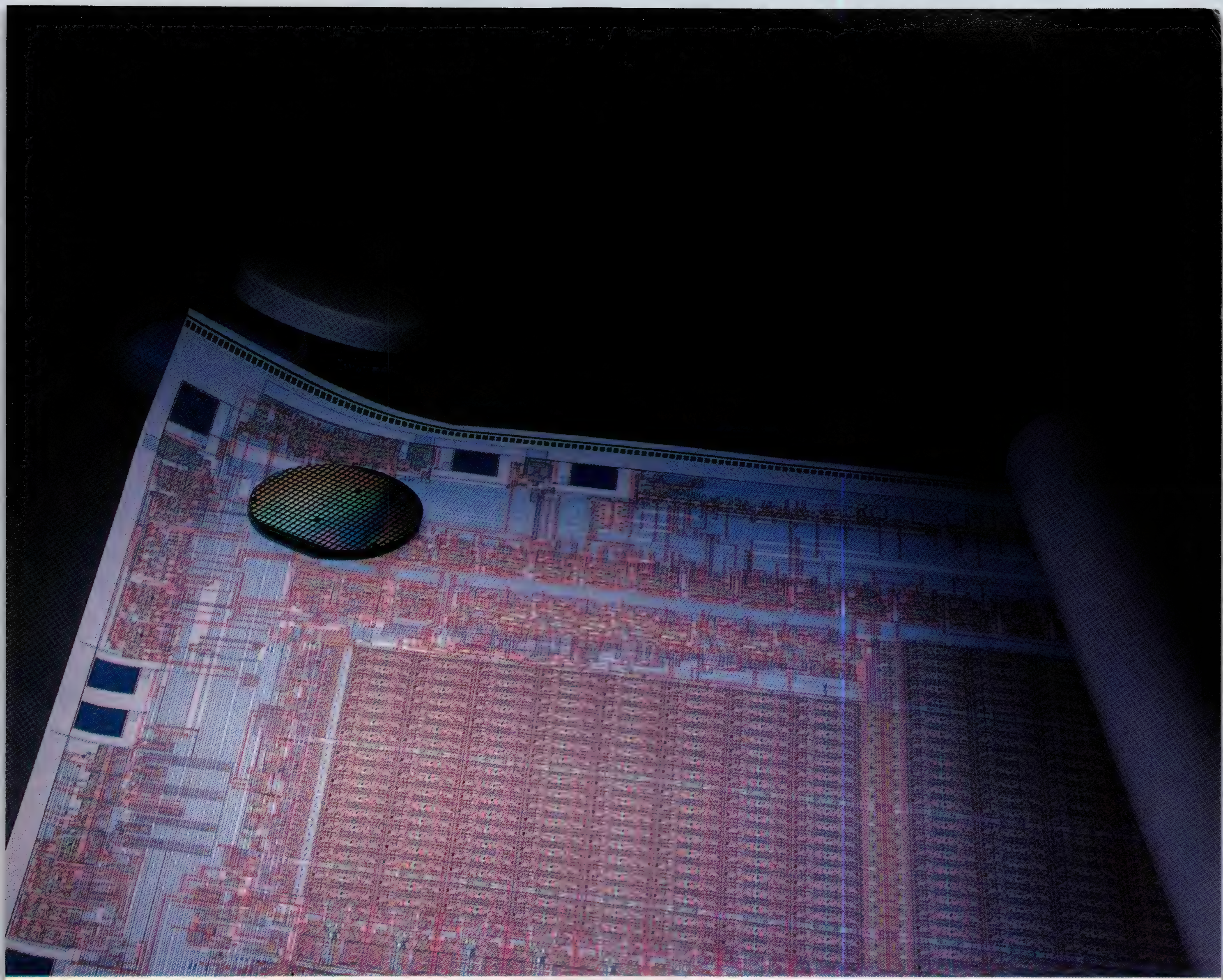

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TMM27256AD~	32KX8	NMOS
TMM27256ADI	32KX8	NMOS
TC57256D	32KX8	CMOS
TC57256AD	32KX8	CMOS
TMM27512D	64KX8	NMOS
TMM27512DI	64KX8	NMOS
TC571000D	128KX8	CMOS
TC571001D	128KX8	CMOS
TC571024D	64KX16	CMOS
ONE TIME PROGRAMMABLE		
TMM2464AP	8KX8	NMOS
TMM2464AF	8KX8	NMOS
TMM24128AP	16KX8	NMOS

PART NO.	ORG.	PROCESS
ONE TIME PROGRAMMABLE		
TMM24128AF	16KX8	NMOS
TMM24256AP	32KX8	NMOS
TMM24256AF	32KX8	NMOS
TC54256AP	32KX8	CMOS
TC54256AF	32KX8	CMOS
TMM24512P	64KX8	NMOS
TMM24512F	64KX8	NMOS
TC541000P	128KX8	CMOS
TC541001P	128KX8	CMOS
ROM		
TC53257P	32KX8	CMOS
TC53257F	32KX8	CMOS
TC531000AP	128KX8	CMOS
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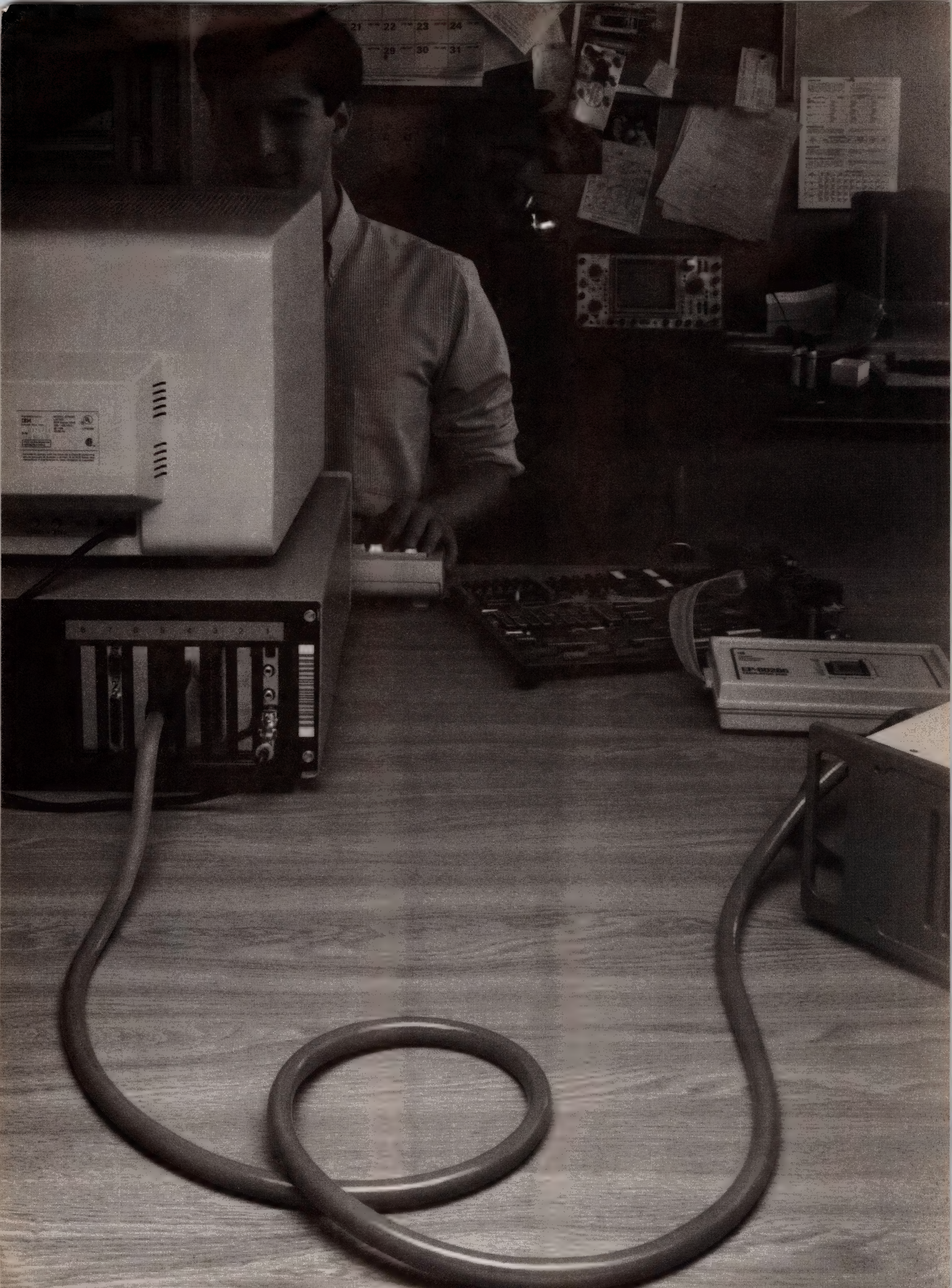

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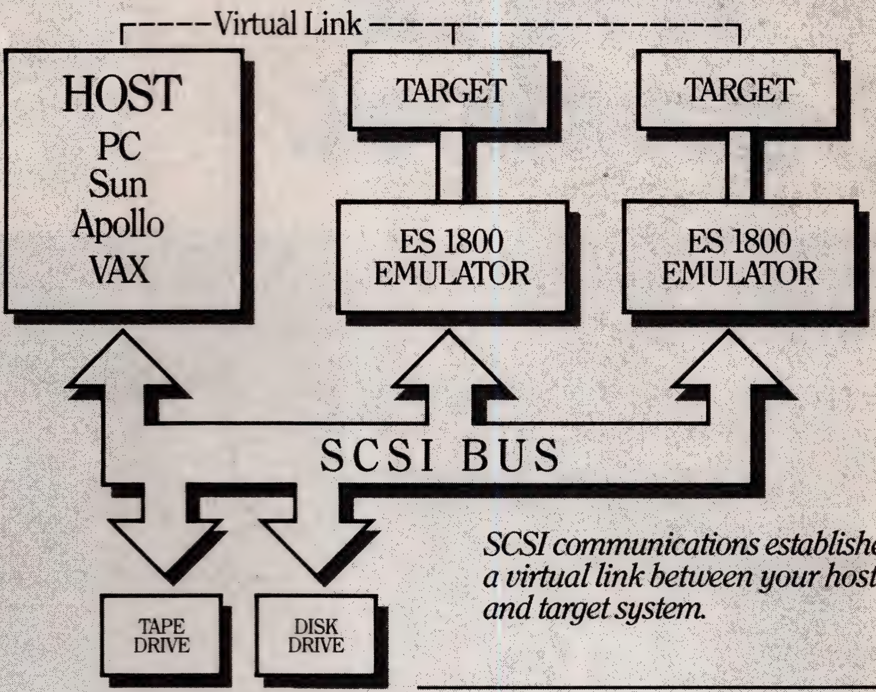

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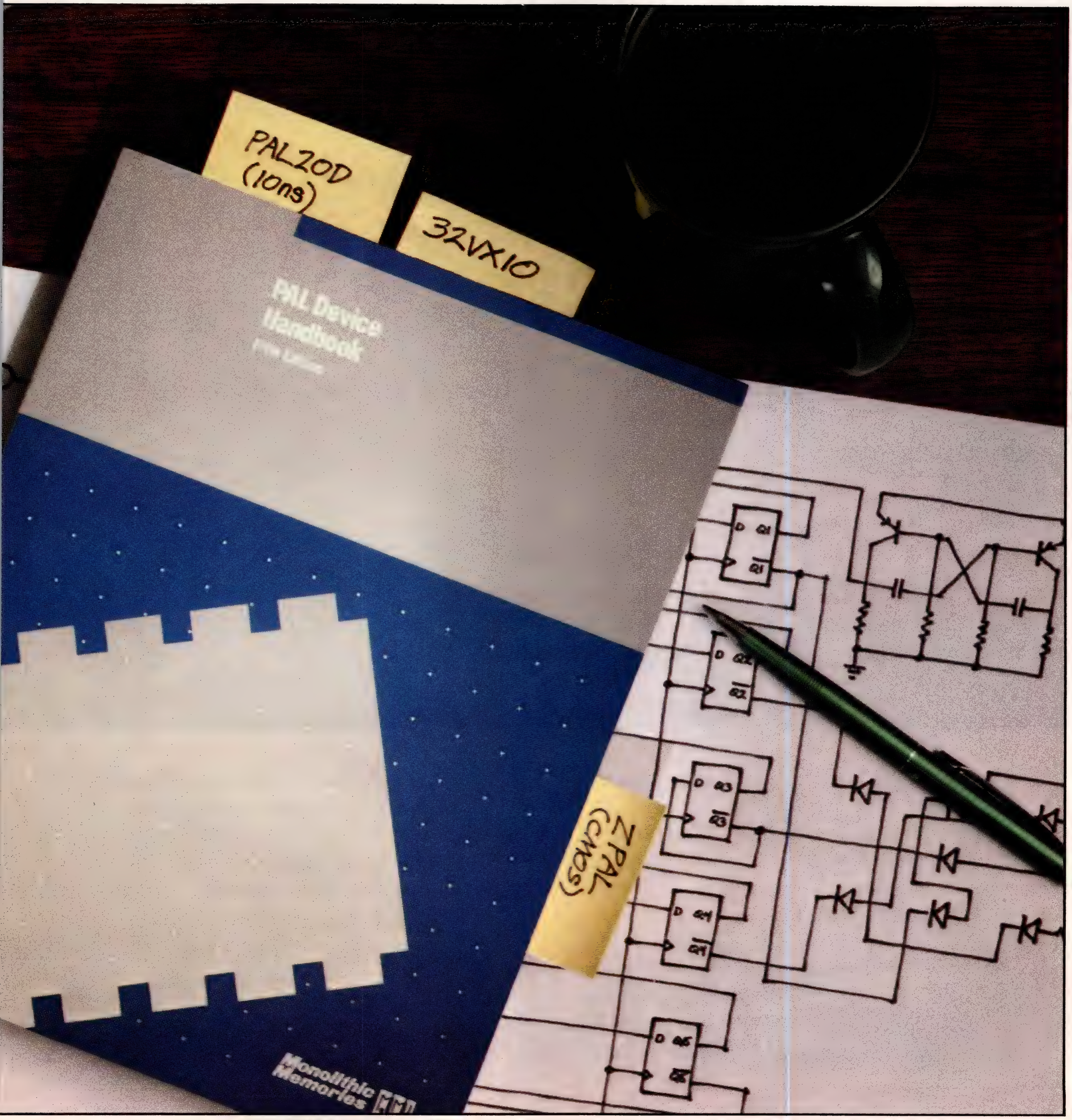

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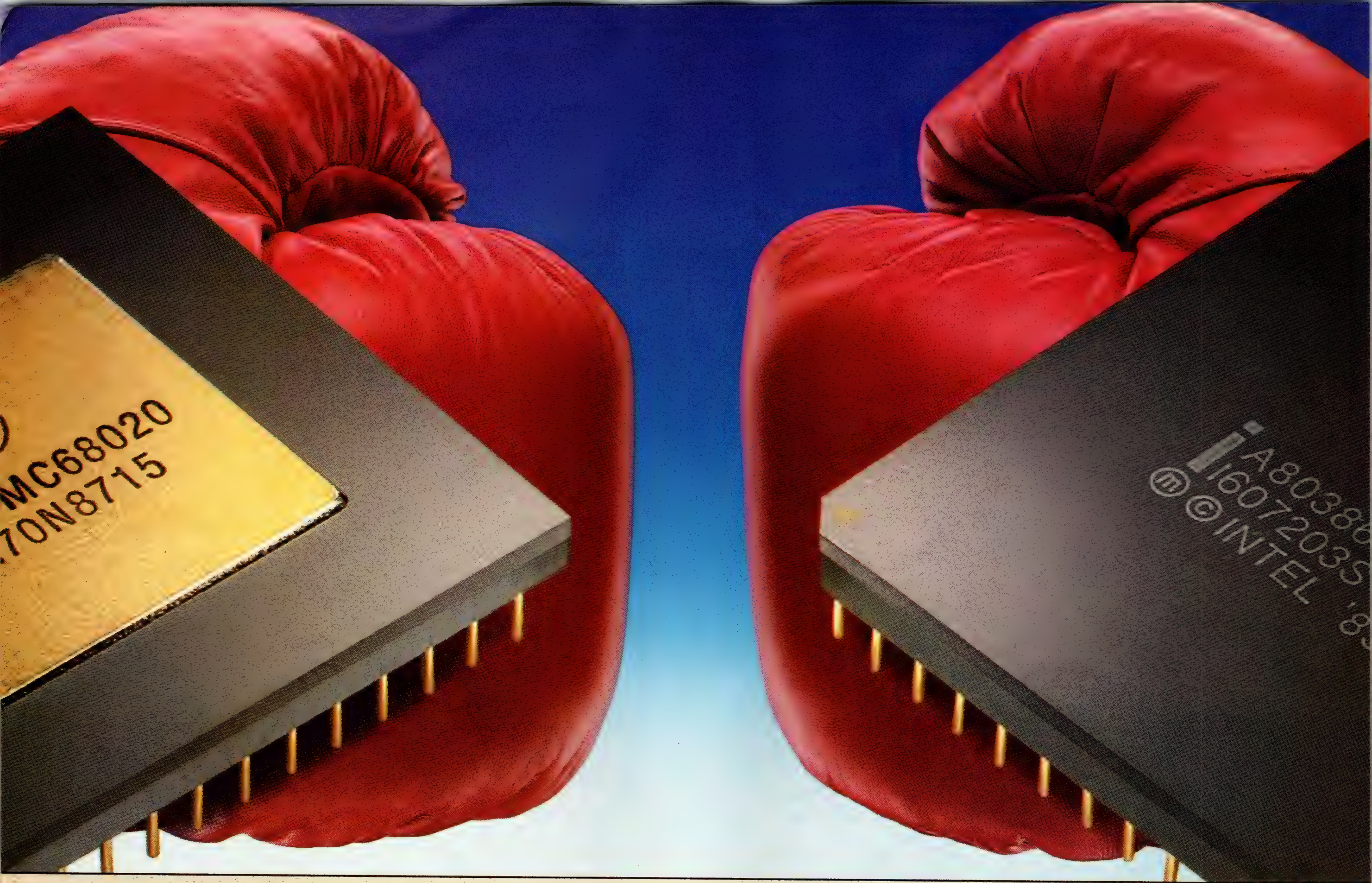

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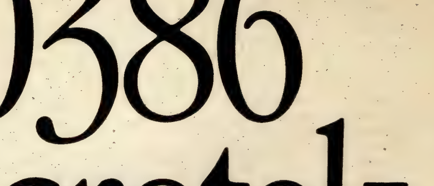

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NEWS BREAKS

EDITED BY JOAN MORROW

TRANSPUTER-BASED PC BUS BOARD IS PROGRAMMED IN C

The Transputer-based T4 PC bus add-in board has both the hardware and software necessary to perform parallel processing on a PC. The board, from Micropar (Newbury Park, CA, (805) 499-0652), has a maximum of four Transputers, each with either 1M or 4M bytes of dedicated RAM. Each Transputer can execute programs independently. Micropar also supplies a C compiler that conforms to the emerging ANSI standard and incorporates special constructs to exploit the T4's parallel architecture.

The board comes with one, two, or four Transputers. The 15-MHz version with one Transputer is $1190; a version with two Transputers is $2190; and a version with four Transputers is $4090. The 20-MHz versions are $1290, $2390, and $4490, respectively. These prices include 1M byte of dynamic RAM per Transputer. The parallel C compiler costs $495.—Margery S Conner

752×564-PIXEL DISPLAY CONTROLLER BOASTS 2-SEC ZOOMING

Providing a dot density of about 5100 pixels/in^2 on a 13-in. display, the Model 752 Nth Engine CAD display controller from Nth Graphics (Austin, TX, (512) 832-1944) also lets you zoom or pan on engineering drawings in less than 2 sec. Onboard RAM (1M byte) stores a display list of vectors to speed on-screen manipulations of large drawings. When used with a multiscanning monitor, such as an NEC Multisync or a Sony Multiscan, the Model 752 produces an image that is 16% finer than you can obtain from a 19-in., 1024×768-pixel monitor offering a dot density of 4900 pixels/in^2. This $2995 controller maintains a 4:5 aspect ratio to produce undistorted circles, and it specs a 60-Hz refresh rate for flicker-free images.—J D Mosley

FLOATING-POINT MICROPROGRAMMABLE COPROCESSOR SOUPS UP PC/AT

The Trisonic coprocessor board from Zalea (Solon, OH, (216) 248-3934) boosts the calculation speed of IBM PC/ATs and compatible computers by combining Weitek's 32-bit Exel 8000 microprogrammable μP and Analog Devices' ADSP3221 and ADSP3210 floating-point multiplier and ALU chips on one expansion board. A $6995 Trisonic-10 version (available eight weeks ARO) can execute 5M instructions/sec, and its arithmetic pipeline can perform 10M single-precision or 6.25M double-precision floating-point operations/sec. The -20 version of the board (available in October) will run twice as fast and cost $9995. The company offers a package of development software, including an assembler for the μP and a microcode assembler, for $2500. C and Fortran compilers will be available in October for $4000 each.—Steven H Leibson

SAMPLING A/D CONVERTERS SUIT DSP APPLICATIONS

The S-to-Z Series converters from Crystal Semiconductor Corp (Austin, TX, (512) 445-7222) are suitable for analyzing voltage signals in DSP applications. These CMOS ADCs feature a unique charge redistribution architecture that provides each device with an inherent sampling function, thus eliminating any need for external sample/hold amplifiers. Using a successive-approximation algorithm, the $69 (100) CSZ5116 sequences through a 16-bit conversion in 16.25 μsec, at sampling rates reaching 50 kHz. On-chip calibration yields 16-bit accuracy with 0.002% typical total harmonic distortion and an 88-dB signal/noise ratio. The $58 (100) 14-bit CSZ5114 supports throughput rates as high as 56 kHz with an 83-dB signal/noise ratio and 0.003% harmonic distortion. The 12-bit CSZ5112 sells for $34 (100) and specs a 63-kHz max sampling rate, a 73-dB signal/noise ratio, and 0.008% distortion.—J D Mosley

NEWS BREAKS

68020-BASED VME BUS CPU HAS 68851 MEMORY-MANAGEMENT CHIP

The CPU-24/25 68020-based single-board computer from Force Computers Inc (Los Gatos, CA, (408) 354-3410) includes the 68851 paged-memory-management unit and the 68881 floating-point coprocessor. The board operates at 16.7 MHz and can accomplish zero-wait-state access of 4M bytes max of static RAM on companion boards. With the math coprocessor, the board sells for $5995. Force has also introduced an 8-user supermicrocomputer that uses the CPU board. The Focus 32/Unix computer system provides 3- to 4-MIPS performance and includes a 170M-byte Winchester drive and a 125M-byte tape drive. With Unix System V release 2, the system sells for $24,950. You can also purchase the real-time operating system UniFLEX/MP for the board or system. Technical Systems Consultants Inc (Chapel Hill, NC, (919) 493-1451) offers the operating system for $1200.—Maury Wright

ECL MULTIPLIER COMPUTES PRODUCTS IN 21.4 nSEC

Three 12-bit ECL multipliers from Motorola Inc (Phoenix, AZ) can operate in four modes: multiply two 12-bit 2's complement numbers producing a 24-bit 2's complement result; multiply two 12-bit unsigned numbers to produce a 24-bit unsigned result; multiply a 12-bit unsigned and a 12-bit 2's complement number producing a 24-bit 2's complement result; and multiply two 13-bit signed-magnitude numbers to produce a 25-bit signed-magnitude result. The three devices in the series—the MC10951R, MC10L951R, and MC100951R—are compatible with 5V, 10K, and 10KH; 4.5V, 10K, and 10KH; and 100K ECL systems, respectively. All of the multipliers compute results in 21.4 nsec or less. When combined in arrays, the devices can compute 24×24- and 48×48-bit products in 38.6 and 73.6 nsec, respectively. All three ICs are packaged in 149-pin pin-grid-array packages and cost $250 (100).—Steven H Leibson

MULTIBUS II SCSI HOST ADAPTER INCLUDES 256k-BYTE BUFFER

Ciprico Inc (Plymouth, MN, (612) 559-2034) now offers a high-performance SCSI host adapter for Multibus II systems. The Rimfire 2500 includes a 256k-byte parity-checked buffer, a 32-bit-wide internal data bus, and a floppy-disk interface. The board transfers data at 1.5M bytes/sec asynchronously and at 4M bytes/sec in the synchronous mode. The board uses the Multibus II Message Passing Coprocessor and an 80186 μP. The company plans to provide operating-system drivers to ease integration of the board into Unix and RMX operating-system applications. The board will be available next month for $2495.—Maury Wright

FULL-DUPLEX, 14.4k-BPS MODEM COSTS $1795

The Performance 1000/144 from Emulex (Costa Mesa, CA, (714) 662-5600) is a full-duplex, leased-line modem that operates at 14.4k bps using trellis-coded modulation. At $1795, the unit's price is close to that of modems running at 9600 bps and about 40% less than previous 14.4k-bps modems. The 8.5×11×2.5-in. modem has no jumpers or switches; you configure and test it by selecting from commands displayed on the 16-character liquid-crytal display. You can also configure and test a remote Performance 1000 through a local unit's front panel.—Margery S Conner

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NEWS BREAKS: INTERNATIONAL

THIN-FILM TECHNOLOGIES GIVE AUSTRALIA A TOEHOLD IN IC FAB

As a first step in bringing semiconductor manufacturing to Australia, Ramax Ltd (Sydney, New South Wales, Australia, (02) 251-4055) has acquired the first licenses for thin-film nonvolatile memory and interconnect technologies developed by Ramtron Corp (Colorado Springs, CO) and the University of Colorado at Colorado Springs. Both technologies are compatible with silicon and GaAs die. Ramax will first manufacture devices using Ramtron's Instant-Circuit technology, which creates fusible interconnections in a thin-film layer applied over a semiconductor and which effectively makes the device a field-programmable part. A properly applied voltage causes the thin film between two conductors to fuse, creating a low-impedance (approximately 200Ω) connection. In the unfused state, the thin film exhibits several megohms of resistance.

Based on the ferroelectric properties of potassium nitrate (KNO_3), the Rampac nonvolatile, thin-film memory can enhance a semiconductor product by allowing a manufacturer to place a fast (20- to 100-nsec) nonvolatile memory array on top of the finished semiconductor die. The thin film contains only the memory cells and requires that the underlying semiconductor supply address decoders and drivers. Because the KNO_3 storage cell operates with geometries as small as 0.1×0.1 μm, the technology is compatible with all lithographic fabrication processes and circuit technologies currently in use. Initially, Ramax plans to add thin-film memory to semiconductor die acquired from other vendors.—Steven H Leibson

μC SUITS AUTOMOTIVE, INSTRUMENTATION, AND INDUSTRIAL USE

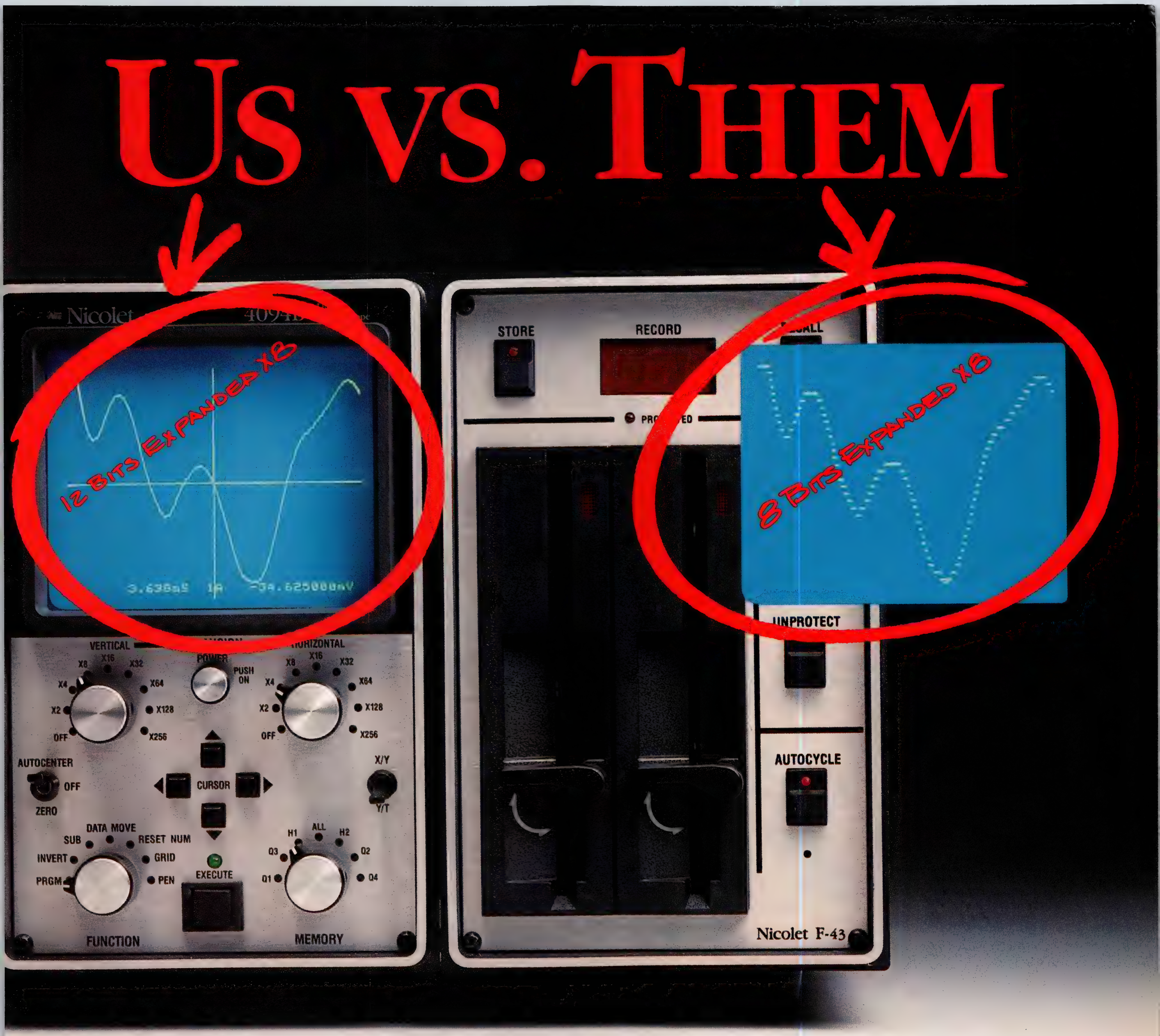
Although the PCB83C552 microcontroller from Philips's Elcoma Div (Eindhoven, The Netherlands, TLX 51573; in the US, Signetics Corp, (408) 991-4571) is targeted for use in automotive engine and gearbox management systems, its variety of analog and digital I/O ports also suits it to instrumentation and industrial-control applications. I/O ports include an 8-channel 10-bit A/D converter, two PWM outputs with 8-bit resolution, an I^2C control interface, and a full-duplex UART. The microcontroller incorporates the 80C51 instruction set and comes with 8k bytes of ROM and 256 bytes of RAM—both expandable off-chip to 64k bytes. Samples are available now; production quantities will be delivered at the beginning of next year. The PCB83C552 is expected to sell for around DM 26 (10,000).—Peter Harold

REAL-TIME OPERATING SYSTEM SUPPORTS 80286 μP

Siemens (Munich, West Germany, TLX 5210025) is about to release RMOS-286—a real-time, multitasking, multiprocessing operating system for the 80286 μP. It will cost approximately DM 10,000. Although initially targeted for use with the company's 80286-based AMS bus CPU card, an enhanced version, slated for release in the 1st qtr of '88, will have message-passing-controller support for a Multibus II CPU card. RMOS-286 supervisor calls are upwardly compatible to those in the company's RMOS-2 operating system but include additional calls for modifying task descriptors and for transforming task selectors and offsets into physical addresses.—Peter Harold

SATELLITE TV IC SIMPLIFIES 2.3-GHz SYNTHESIZER DESIGN

Suited for use in the antenna head of satellite TV receivers, the SP5062 fixed-modulus 2.3-GHz frequency synthesizer from Plessey Semiconductors (Swindon, UK, TLX 449637; in the US, (714) 472-0303) requires only a suitable VCO to form a complete PLL synthesizer. The device's phase comparator has an output amplifier, around which you can apply local feedback; only one external transistor is required to interface the device to varicap tuning diodes. The SP5062 costs £7.25 (1000).—Peter Harold



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tiny SPDT switch

dc to 6GHz... $32.95 (1-24)

Tough enough to pass stringent MIL-STD-202 tests, useable from dc to 6GHz operation, and smaller than most RF switches, Mini-Circuits' hermetically-sealed KSW-2-46 offers a new, unexplored horizon of applications. Unlike pin diode switches that become ineffective below 1MHz, this GaAs switch can operate down to dc with control voltage as low as -5V, at a blinding 2ns switching speed.

Despite its extremely tiny size, only 0.185 by 0.185 by 0.06 in., the KSW-2-46 provides 50dB isolation (considerably higher than many larger units) and insertion loss of only 1dB. The surface-mount unit can be soldered to pc boards using conventional assembly techniques. The KSW-2-46, priced at only $32.95, is yet another example of components from Mini-Circuits with unbeatable price/performance.

Switch fast... to Mini-Circuits' KSW-2-46

SPECIFICATIONS		
FREQ. RANGE	dc-4.6 GHz	
INSERT. LOSS (db)	typ	max
dc-200MHz	0.9	1.1
200-1000MHz	1.0	1.3
1-4.6GHz	1.3	1.7
ISOLATION (dB)	typ	max
dc-200MHz	60	50
200-1000MHz	45	40
1-4.6GHz	30	23
VSWR (typ)	1.3:1	
SW. SPEED (nsec) rise or fall time	2(typ)	
MAX RF INPUT (dBm)		
up to 500MHz	+17	
above 500MHz	+27	
CONTROL VOLT.	-8V on, OV off	
OPER/STOR TEMP.	-50 to +100°C	
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LOW PASS	Model *LP-	10.7	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to		10.7	32	48	60	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)		19	47	70	90	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): P $9.95 (6-49), B $24.95 (1-49), N $27.95 (1-49), S $26.95 (1-49)

HIGH PASS	Model *HP-	50	100	150	200	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	190	290	365	460	520	570	660	720

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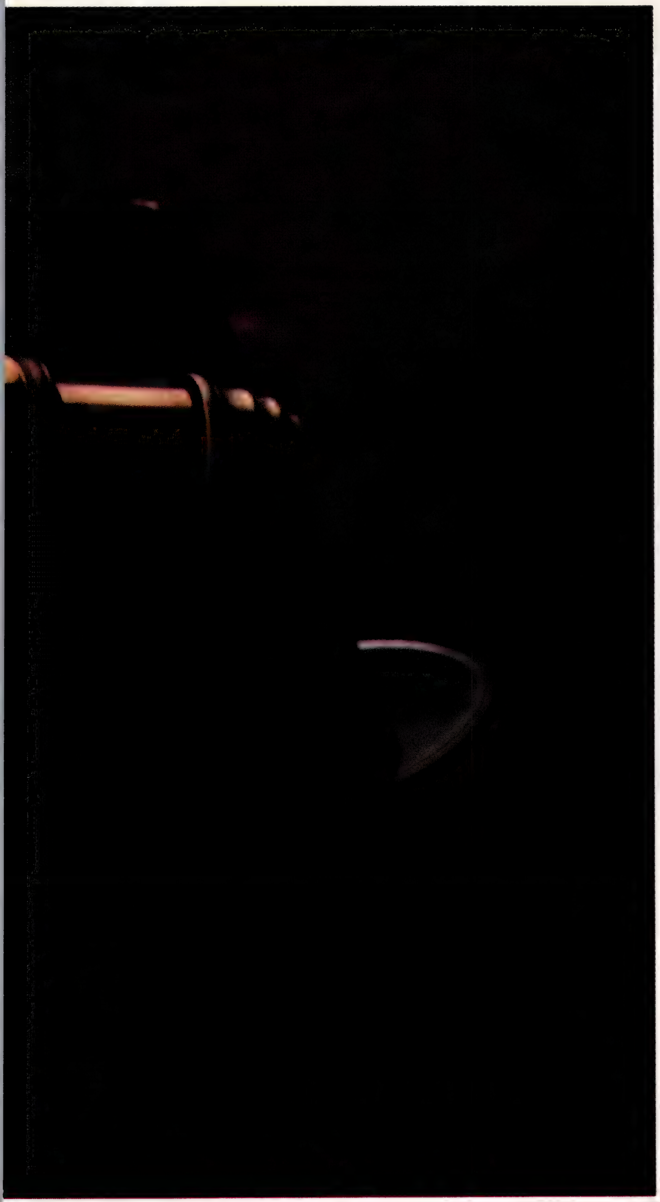

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Specification		serial	disk	graphics
		ISIO-1/2 8-channel serial I/O	ISCSI-1 SCSI interface	AGC-1/2 advanced graphics controller
Hardware	Processor	68010/10 MHz	68010/10 MHz	63484/8 MHz
	Dual ported memory	128/512K no wait state	128/512K no wait state	2 MB no wait state
	Interface	8 x RS232/RS422	SCSI/SA 460	RS434 (RGB)
	Speed	RS232 : 38400 baud RS422 : 2 M baud	1.5 Mbit/sec	64 MHz pixel frequency 1600 x 1280 pixels
Software	Driver support	PDOS*, UNIX* V	PDOS*, UNIX* V	PDOS*, UNIX* V
	Unique SW packages	firmware based on real time kernel	hashing and caching firmware	GKS 2. 0b
	Availability	now	now	now

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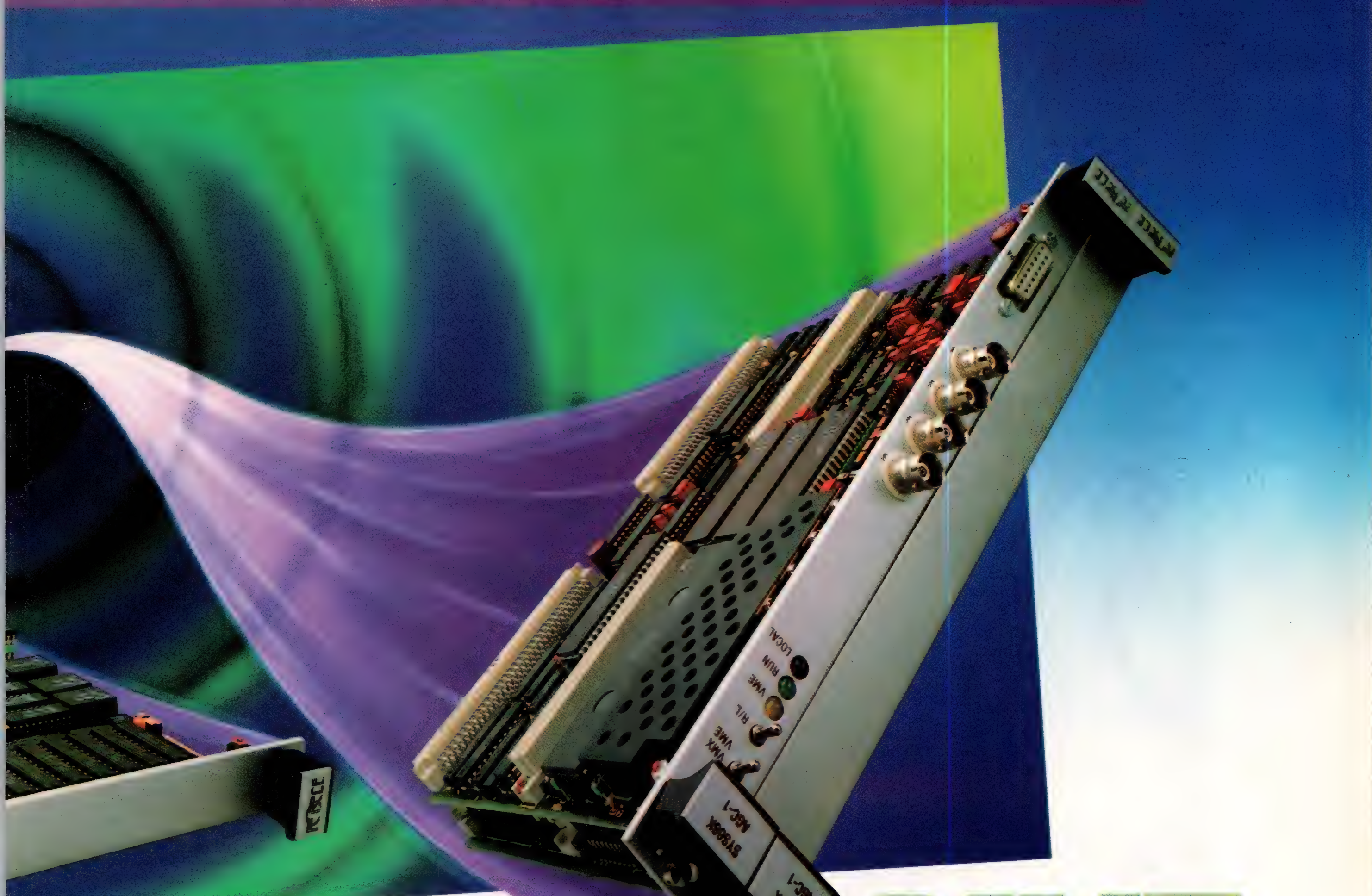
intelligence



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SIGNALS & NOISE

IRA rules hurt the self-employed

The editorial concerning IRAs ("IRAs deserve another chance," EDN, April 15, pg 63) did not mention one class of persons left out of the new tax legislation. Because I am self-employed, I was not concerned with the changes in the tax law; I was not covered by a qualified plan and thus would still be able to contribute to my IRA.

But surprise: Because my wife contributes 7% of her *after*-tax income to the Ohio state teachers' retirement fund, I am unable to put any *before*-tax dollars into my IRA.

It seems that self-employed individuals have been singled out for "special treatment" again.

Stephen F Bean
MicroPlot Systems Co
Westerville, OH

"HE'S PHENOMENAL! WHENEVER I ATTEMPT TO CRITICIZE HIS WORK, HE SHOWS A REMARKABLE ABILITY TO RECOGNIZE AND POINT OUT MANY OF MY OWN PERSONAL ATTRIBUTES."

High turnover denies engineers benefits

The April 15 editorial on IRAs hit on an issue important to me; I had written to my US representatives and senators just a few months ago on the same subject. I pointed out in my letters that the engineering profession, unlike many others, is so dynamic and fast paced that the high average job-turnover rate prevents many, if not most, engineers from ever seeing substantial pension benefits during their careers.

Why is there such high job turnover among engineers? It's not at all unusual for an electronics or computer company to go from start-up to industry leader and back to obscurity in just a few years. Hardly enough time to vest a pension. Typically, stable companies are the most boring, least interesting, and least innovative places to work at the individual level. A long-term career at such a company usually deteriorates to a poor working environment, poor work assignments, little

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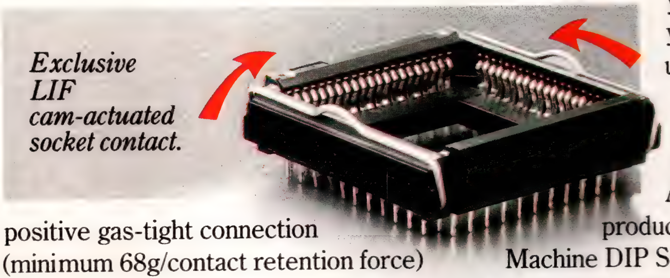
CIRCLE NO 3

THOMAS & BETTS TAKES THE PRESSURE OFF CHIP DAMAGE.

Easier chip carrier socket insertion/extraction cycles shouldn't occur at the expense of possible chip damage from too much insertion/extraction force pressure. Our unique Ansley® Plastic Chip Carrier Socket with its exclusive cam-actuated socket contact design provides a positive gas-tight connection (minimum 68g/contact retention force) at a low 50g/contact maximum insertion/extraction force — perfect for VLSI and high density applications.



The socket's polarizing feature assures positive chip carrier orientation, and the socket can be installed on PC boards without special tooling.

The Ansley® cam-actuated LIF PLCC is available in four sizes (44, 52, 68 and 84 positions on .050″ centers) in through-hole mount contact style. Sockets feature phosphor bronze contacts with tin/lead plated leads on .100″ sq. grid patterns.

When the job has to get done fast, *and with a minimum of risk and unnecessary cost,* take the pressure off yourself as well as your chip, depend upon the T&B Electronics Division to provide the means. Additional Ansley® socket products include Screw-Machine DIP Sockets, Pin Grid Array Sockets, IC Sockets with built-in decoupling capacitor circuits, and Stacked- DIP Sockets.

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CIRCLE NO 169

sense of accomplishment, diminished self-esteem, smaller pay raises, salary compression, and so on. Either way, engineers lose benefits. And it doesn't serve the country well to waste engineering talent this way.

One way engineers attempt to counter technical stagnation and boredom is cross-pollination: Frequent job-assignment changes and personnel shuffling can keep fresh ideas circulating and help keep engineers from suffering burnout. Some companies are good at creating an environment that consistently remains an interesting place to work. Other companies—the vast majority, I suspect—are either incapable of maintaining or too short-sighted to sustain an interesting, dynamic environment. This situation leaves the engineer with the often unpleasant choice of finding a better job or staying in a dead-end one and hoping that it lasts long enough to vest some pension benefits. I've seen it happen to others I've worked with, and I don't intend to let it happen to me.

Unfortunately, our lawmakers don't seem to understand the broad needs of this nation's engineers, and we, as engineers, cannot afford to sit back quietly. We need to write to our lawmakers and voice our concerns; we need to make them aware of our problems.

Richard Alan Hamersley
MAI Basic Four Inc
Tustin, CA

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CIRCLE NO 4

IEEE should pursue better retirement plans

I can identify with the editorial in the April 15 issue of EDN, because I'm one of those employees of a company that has no 401K, tax-deferred savings, or pension plan.

Personally, I believe that the IEEE should continue to pursue better IRA plans for engineers who aren't able to vest in any retirement plan. Thanks for the publicity and awareness.

David Fong
San Jose, CA

Clock rate

An editing error crept into the Design Idea "Pulse-width checker is programmable" by Trung D Nguyen (EDN, April 15, pg 214). The clock rate mentioned on both pg 214 and pg 216 should be 100 *MHz*, not 100 kHz.

WRITE IN

Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

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And now, we bring you the new HP 54111D/54112D/54120T series.

These high-performance digitizing oscilloscopes let you measure what you've never measured before, with superb accuracy and ease of use.

You'll find innovations such as 20 GHz bandwidth, 4-channel simultaneous 400 MSa/sec with 64k memory per channel, time domain reflectometry (TDR) with normalization, 10 psec time interval accuracy, and more.

HP 54111D: the hot single shot.

The HP 54111D offers two simultaneous channels operating at up to 1 Gigasample per second...allowing you to capture high-speed single-shot phenomena such as high-speed pulses, plasma discharge, high voltage arcing, high frequency bursts, laser pulses and high energy events.

You get the single-shot performance of analog storage oscilloscopes with all of the performance advantages of digitizing oscilloscopes.

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The HP 54112D offers you simultaneous 4-channel capture at 400 Megasamples per second with 64k of memory per channel. Just right for the long data streams found in serial data communication applications.

HP 54111D

☐ 1 Gigasample/sec digitizing rate
☐ 500 MHz repetitive bandwidth
☐ 250 MHz single-shot bandwidth
☐ 8k memory per channel
☐ 1 mV/div sensitivity

HP 54112D

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☐ 100 MHz repetitive or single-shot
☐ 4 simultaneous channels
☐ 64k memory per channel

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HP 54120T

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- ☐ 10 psec time interval accuracy
- ☐ 0.25 psec time interval resolution
- ☐ Time and voltage histograms
- ☐ Stable TDR with normalization
- ☐ 0.4% voltage accuracy
- ☐ 4 channels

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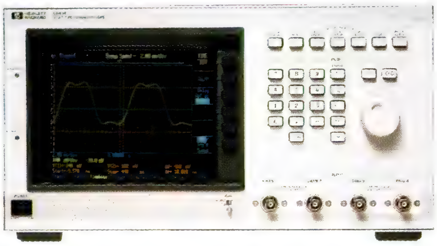

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VERTICAL	
Rep. bandwidth	500 MHz
S.S. bandwidth	250 MHz
Inputs	2 chan & 2 trig
Resolution	8 bit to 25 MHz, 7 bit to 100 MHz, 6 bit to 250 MHz
Sensitivity	1 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm
HORIZONTAL:	
Digitizing rate (max)	1 GSa/sec
Resolution	10 psec
Pre-trigger viewing	YES
MEMORY:	
Acquisition/chan	8k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm
Nonvolatile instrument setups	10

HP 54112D $22,900.00*

VERTICAL:	
Rep. bandwidth	100 MHz
S.S. bandwidth	100 MHz
Inputs	4 chan & 1 trig
Resolution	6 bit to 100 MHz
Sensitivity	5 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm
HORIZONTAL:	
Digitizing rate (max)	400 MSa/sec
Resolution	40 psec
Pre-trigger viewing	YES
MEMORY:	
Acquisition/chan	64k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm
Nonvolatile instrument setups:	10

HP 54120T $27,850.00**

VERTICAL:	
Rep. bandwidth	20 GHz
S.S. bandwidth	NO
Risetime	17.5 psec
Accuracy	0.4%
Inputs	4 chan & 1 trig
Resolution	12 bits
Sensitivity	1 mV/div to 80 mV/div
Coupling	50 Ohm
HORIZONTAL:	
Accuracy	10 psec
Resolution	0.25 psec
Pre-trigger viewing	NO
Range	10 psec/div-1 s/div
MEMORY:	
Acquisition/chan	0.5k
Waveform storage	2 pixel (volatile), 4 rep wfm (nonvolatile)
Nonvolatile instrument setups:	10
TDR	
Pulse source	
Amplitude	0-200 mV
Risetime	35 psec
Flatness	1%
Normalization	YES
Waveform histograms	YES

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Varies according to options selected.
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Includes both the HP 54120A and HP 54121A.

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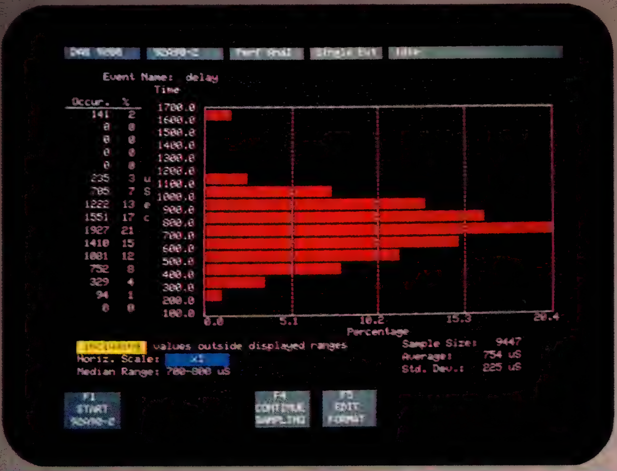
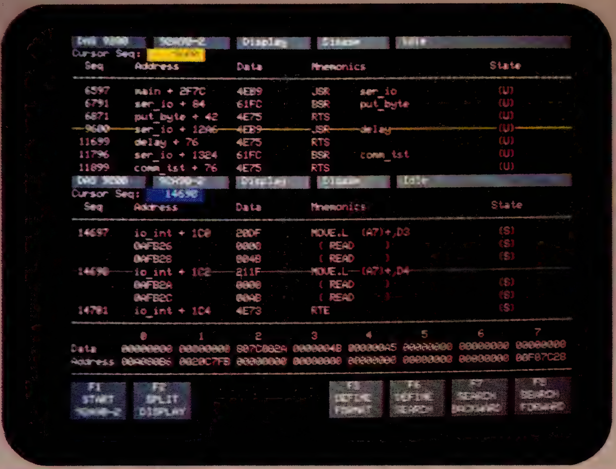
CIRCLE NO 180

DAS9200 DIGITAL ANALYSIS: NOW TEK MAKES THE IMPOSSIBLE LOOK EASY.



```
Event Name:  delay
                 Time
Occur.  %
  141   2      1700.0
    0   0      1600.0
    0   0      1500.0
    0   0      1400.0
    0   0      1300.0
    0   0      1200.0
  235   3  u   1100.0
  705   7  S   1000.0
 1222  13  e    900.0
 1551  17  c    800.0
 1927  21       700.0
 1410  15       600.0
 1001  12       500.0
  752   8       400.0
  329   4       300.0
   94   1       200.0
    0   0       100.0
              0.0     5.1     10.2     15.3     20.4
                          Percentage
         values outside displayed ranges     Sample Size:   9447
Horiz. Scale:                                Average:      754 uS
Median Range: 700-800 uS                     Std. Dev.:    225 uS
```

Software Performance Analysis, like this distribution of a subroutine's execution times, helps you easily understand the activity of your code.



```
Cursor Seq:
 Seq     Address          Data     Mnemonics              State
  6597   main + 2F7C      4EB9     JSR     ser_io          (U)
  6791   ser_io + 84      61FC     BSR     put_byte        (U)
  6871   put_byte + 42    4E75     RTS                     (U)
  9600   ser_io + 12A6    4EB9     JSR     delay           (U)
 11699   delay + 76       4E75     RTS                     (U)
 11796   ser_io + 1324    61FC     BSR     comm_tst        (U)
 11899   comm_tst + 76    4E75     RTS                     (U)
Cursor Seq:   14698
 Seq     Address          Data     Mnemonics              State
 14697   io_int + 1C0     20DF     MOVE.L  (A7)+,D3        (S)
         0AFB26           0000      ( READ      )          (S)
         0AFB28           0048      ( READ      )          (S)
 14698   io_int + 1C2     211F     MOVE.L  (A7)+,D4
         0AFB2A           0000      ( READ      )          (S)
         0AFB2C           004B      ( READ      )          (S)
 14701   io_int + 1C4     4E73     RTE                     (S)
            0        1        2        3        4        5        6        7
Data     00000000 00000000 007C002A 0000004B 000000A5 00000000 00000000 00000000
Address  000000B6 0020C7FB 00000000 00000000 00000000 00000000 00000000 00F07C28
```

Step backwards through acquired data, including subroutines, stack and register models, using time-correlated split-screen displays to pinpoint problems.

In every dimension — speed, channel width, memory depth, trigger capability, modularity and ease of use — the DAS9200 dwarfs what's been possible before.

The DAS9200 features a tightly coupled, high-speed architecture in which multiple card modules can act as a single unit. Large color-coded displays, pop-up menus, performance analysis graphs,

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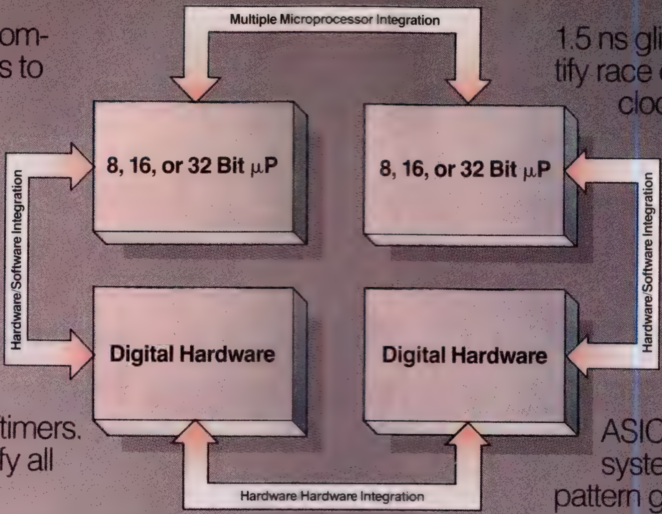
multi-tasking and more combine to take logic analysis to levels like these:

1 State-driven triggering at 200 MHz. You can use up to 384 channels of sync and async data acquisition. You can assurance-test high-speed logic at full speed, using 4-level state tracking and high-speed counter/timers. You can monitor and verify all timing measurements in a circuit.

2 Symbolic, real-time software debugging. Register deduction and stack simulation let you pinpoint problems like stack overflow or incorrectly restored pointers—without breakpoints or manual notation.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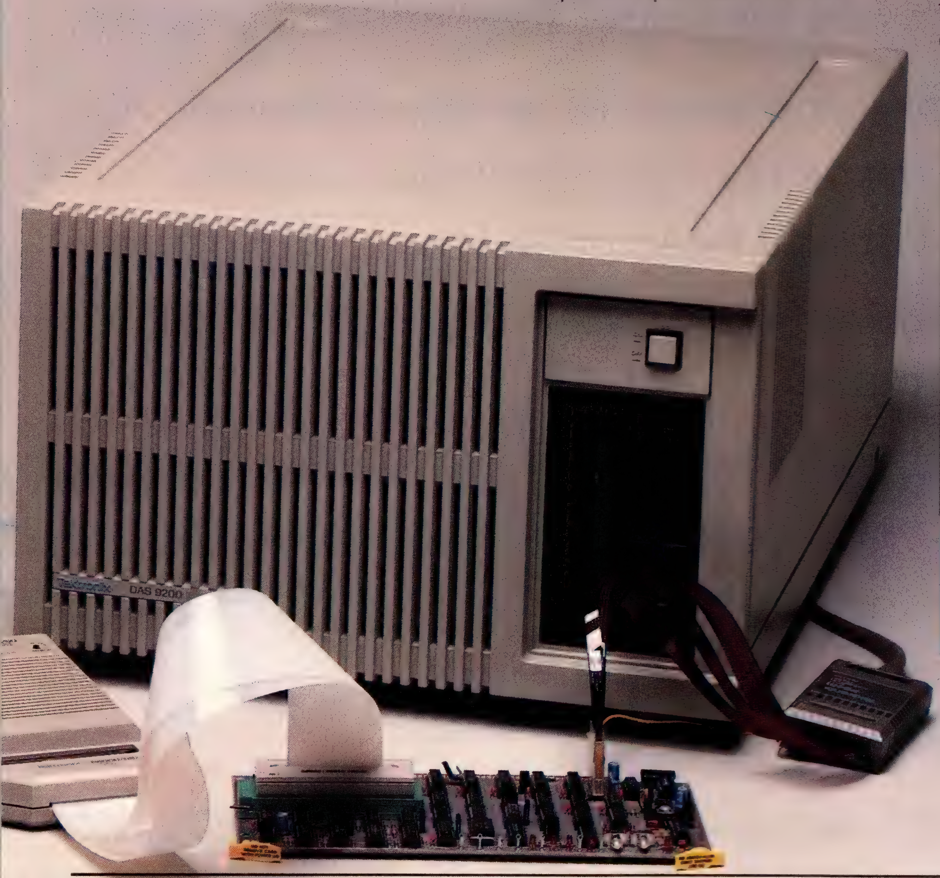
3 Simultaneous integration of up to six microprocessors. Use the dual timebases and real-time handshaking between system modules to set up split-screens displays that scroll in precise time alignment.

4 160 channels of acquisition at 2 GHz. Use up to 500 ps sample interval and 1.5 ns glitch detection to identify race conditions, spurious clocks and setup/hold violations in any logic family. System probes feature input capacitance of <1 pf.

5 Easy ASIC verification at up to 50 MHz. The DAS9200 is available as a low-cost turnkey ASIC device verification system. Featuring 50 MHz pattern generation, 8K bit vector depth, and 1 ns edge placement, it offers the power, precision and simplicity to be an attractive alternative to centralized systems.

6 Stop wishing for the impossible in digital analysis: Compare your wish list against the complete list of DAS9200 capabilities. Contact your Tek sales engineer, or call toll-free for more information. **Call 1-800-245-2036.** In Oregon, 1-213-1220.

Available in desktop and rack-mount versions, the DAS9200 mainframe can be augmented with up to three expansion mainframes for a total of 28 card slots.



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April 8, 1987

Mr. Irwin Feerst

RE: Possibility of Your Being Charged Before the IEEE Member Conduct Committee For Violation of the IEEE Code of Ethics

SUBJECT: Suggested Resignation ⟵

Dear Mr. Feerst:

You have publically, both in your newsletter as well as in your letters to the IEEE Board of Directors with copies to the press, attacked Japanese professionals as well as many foreign professionals teaching in the U.S. or employed by U.S. industry.

Permit me to bring your attention that by your continued membership in the IEEE, you have reaffirmed each year that you will be in compliance with IEEE Bylaws. This is required by the language on the back of your membership card. Membership in the IEEE is voluntary.

By your decision to belong, your voluntarily agreed to the conditions of membership. They are binding upon you as long as you choose to continue your membership.

In this context, let me quote to you Article II of the Code of Ethics which is an integral part of the Bylaws: "Members shall in their work treat fairly all colleagues and co-workers, regardless of race, religion, sex, age or national origin."

You realize that any IEEE member can bring an action against another IEEE member for violation to the IEEE Code of Ethics. As a working journalist-engineer, you may want to resign voluntarily before some irate "foreigner", a member in good standing, may decide to bring such an action against you.

Very truly yours,

Bruno O. Weinschel
(1986 IEEE President)
IEEE Fellow Since 1966

Bruno Weinschel was president of the IEEE in 1986. His letter shows the inability of the IEEE to tolerate any dissent, especially if it means supporting the American working engineer against the interests of the professors and the corporate executives.

The Committee of Concerned EEs has been active in the effort to elevate the status of all American working technical professionals. We have fought against the incursion of lower paid foreign engineers; we have issued a position paper advising engineers of their rights under the Age Discrimination in Employment Act; we have urged that papers appearing in IEEE's journals be useful to the practitioner, instead of providing the academics with the means of publishing; etc.

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CIRCLE NO 5

CALENDAR

Directions and Implications of Advanced Computing, Seattle, WA. Computer Professionals for Social Responsibility, Box 85481, Seattle, WA 98105. Jonathan Jacky, (206) 548-4117, or Doug Schuler, (206) 783-0145. July 12.

PC-Based Tools for Software Analysis and Design (short course), Boston, MA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. July 14 to 17.

Personal Computer Interfacing and Instrument Automation, Washington, DC. Linda Leffel, C E C, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. (703) 961-4848. July 16 to 18.

Designing Signal Processors with DSP and Bit-Slice Chips (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. July 21 to 24.

Hands-On Expert Systems Design and Development (short course), Anaheim, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. July 21 to 24.

PC-Based Tools for Software Analysis and Design (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. July 21 to 24.

Siggraph (Conference on Computer Graphics and Interactive Techniques), Anaheim, CA. Smith Bucklin and Associates, 111 E Wacker Dr, Suite 600, Chicago, IL 60601. (312) 644-6610. July 27 to 31.

Designing Signal Processors with DSP and Bit-Slice Chips (short course), Los Angeles, CA. Integrated Computer Systems, Box

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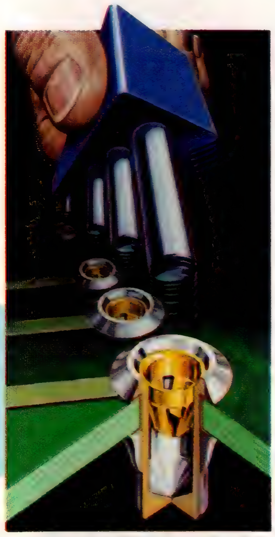

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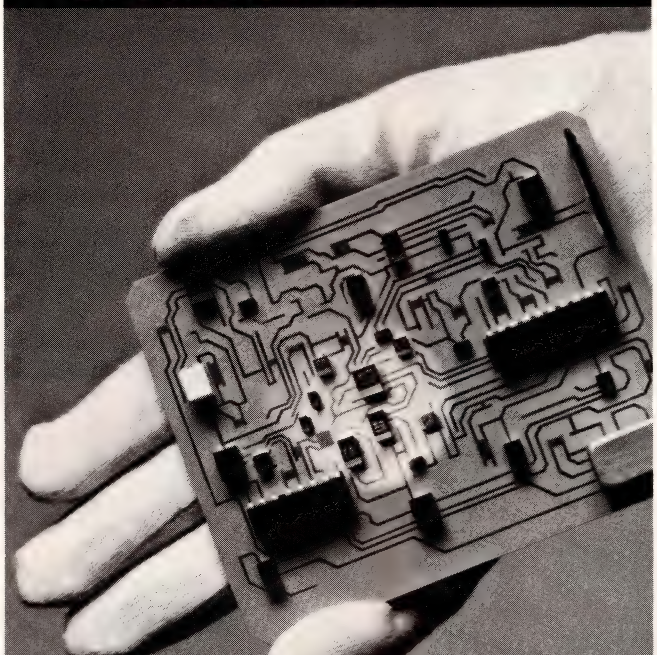

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CIRCLE NO 7

CALENDAR

3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. July 28 to 31.

Illuminating Engineering Society Annual Conference, Scottsdale, AZ. Illuminating Engineering Society of North America, 345 E 47th St, New York, NY 10017. (212) 705-7915. August 2 to 6.

SIMS '87 (Symposium for Innovation in Measurement Science), Geneva, NY. Instrument Society of America, 67 Alexander Dr, Research Triangle Park, NC 27709. (919) 549-8411. August 2 to 7.

Effective Skills for Technical Managers (short course), San Francisco, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

Hands-On Expert Systems Design and Development (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

PC-Based Tools for Software Analysis and Design (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

International Computers in Engineering Conference and Exhibition, New York, NY. American Society of Mechanical Engineers, 345 E 47th St, New York, NY 10017. (212) 705-7795. August 9 to 13.

Advanced SMT Design Techniques (short course), San Jose, CA. Surface Mount Technology Plus, 2216 Lundy Ave, San Jose, CA 95134. (408) 943-0196. August 17 to 18.

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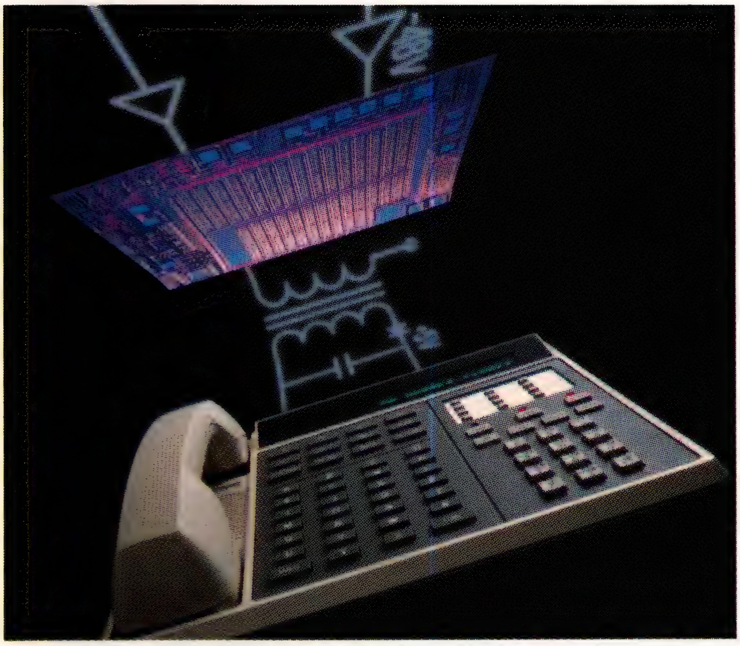

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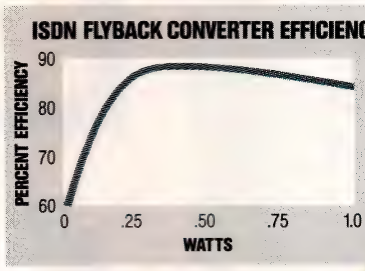

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68154	Interrupt generator IGOR	Interrupt generator providing for VME or VERSA bus, generates 7 bus interrupt requests. Speed: 11MHz
68155	Interrupt handler IVHAN	Accepts interrupts from 14 sources which are prioritized to one of 7 levels. Local master IACK cycle with vector from 68154. Speed: 10MHz
68172	VME bus controller buscon	VME bus controller interface circuit. Master/slave configurations, processor or DMA interface. Speed: 25MHz

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54F32	Quad 2-Input OR Gate
54F38	Quad 2-Input NAND Buffer, O/C
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54F112	Dual J-K Negative Edge-Triggered Flip-Flop
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54F163A	4-Bit Binary Counter, Synchronous Reset
54F169	4-Bit Up/Down Binary Synchronous Counter
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54F240	Octal Inverting Bus/Line Driver, 3-State
54F244	Octal Bus/Line Driver, 3-State
54F245	Octal Bus Transceiver, 3-State
54F251	8-Input Multiplexer, 3-State
54F253	Dual 4-Input Multiplexer, 3-State
54F257A	Quad 2-Input Multiplexer, 3-State
54F258A	Quad 2-Input Multiplexer, 3-State
54F280A	9-Bit Odd/Even Parity Generator/Checker
54F283	4-Bit Adder
54F367	Hex Buffer/Driver, 3-State
54F373	Octal Transparent Latch, 3-State
54F374	Octal D Flip-Flop, 3-State
54F381	4-Bit Arithmetic Logic Unit
54F398	Quad 2-Port Register
54F521	8-Bit Identity Comparator
54F534	Octal D Flip-Flop, 3-State

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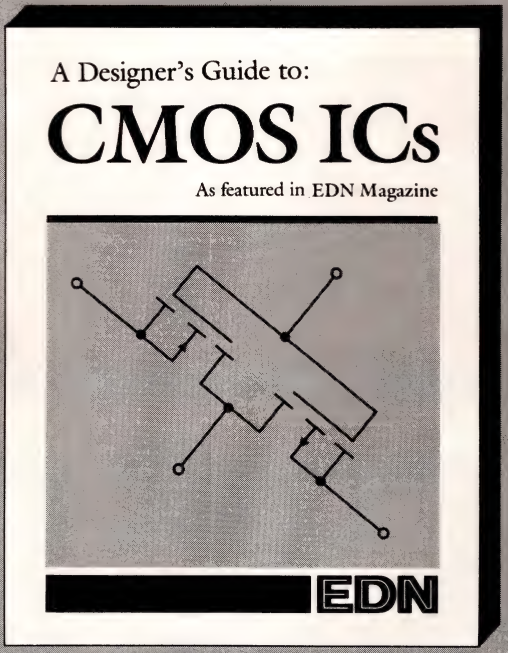

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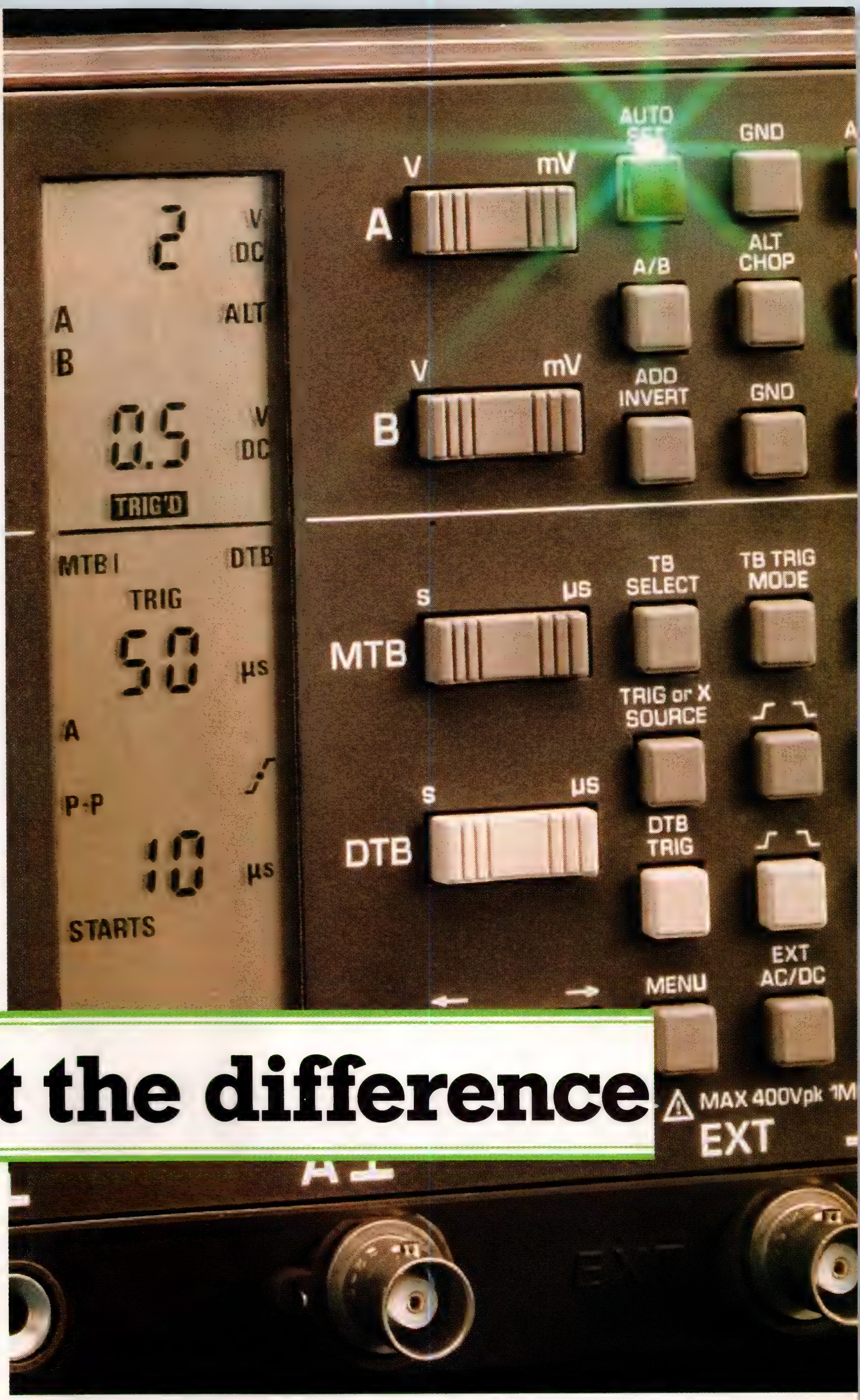

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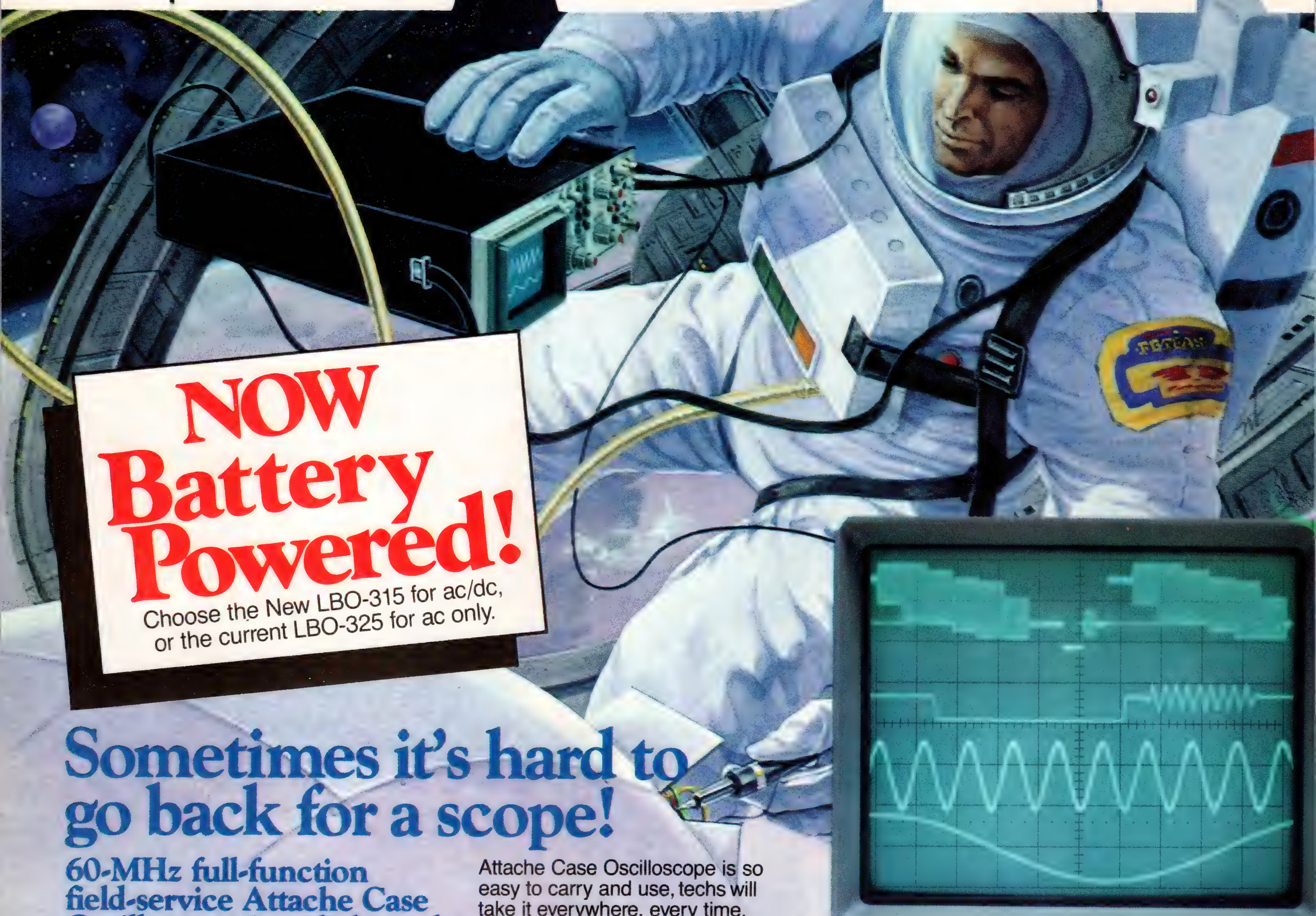

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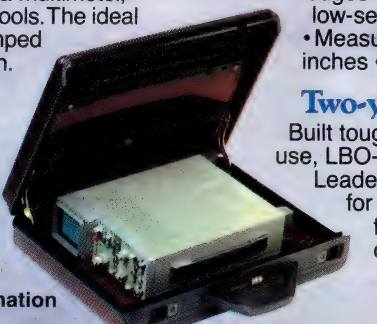

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Circle 105 for product demonstration

EDITORIAL

Score: Low Tech 1, High Tech 0

That inexpensive low-tech weapons are often as effective as their high-tech counterparts is a lesson we should have learned some time ago. For example, during the Falkland Islands war several ships, including the *HMS Sheffield* and the supply ship *Atlantic Conveyor,* were sunk by inexpensive Exocet missiles. But we're slow learners: A similar missile attack took place in 1967, when the Egyptians sank an Israeli destroyer.

The Argentineans weren't alone in taking advantage of older, reliable technology during the Falklands war. Unwilling to gamble on a new, sophisticated torpedo, the captain of the British submarine that sank the *General Belgrano* fired a WW II-vintage torpedo instead. Other adversaries know that when simple weapons are used properly they are often more reliable than those that incorporate high technology. Consider the simple car bombs used in Lebanon and the old weapons the Cubans used in Grenada.

History often repeats itself. In mid May, an Iraqi Exocet missile penetrated US naval defenses in the Persian Gulf and killed 37 US seamen on the *USS Stark*. Although onboard weaponry such as electronic-warfare equipment and Phalanx automatic cannon was manned, it failed to stop the attack. High technology didn't provide a solution for equipment failure or for a failure in the ship's command.

Often, we put too much stock in technology itself and too little in its effectiveness and the judgment of the people who must manage it. During Israel's invasion of Lebanon, US military leaders crowed about the superiority of US high-tech weapons over Syria's air-defense system. In fact, many Israeli weapons were low tech: Drones tricked the Syrians into turning on radars which Shrike and HARM missiles—available since the mid 60s—promptly destroyed. Many observers found that innovative tactics, daring leaders, and surprise were the real keys to Israel's success.

Now the US Air Force proclaims a Super Cockpit project that will replace most cockpit instruments with computer-generated displays. Holograms, smart sensors, and speech synthesizers are among the high-tech items set for use in future cockpits. Also, the Army wants a new attack-utility helicopter (LHX) that will incorporate highly technical electronic equipment. Unfortunately, the sophisticated electronic equipment has already added half a ton to the LHX's weight and over 30% to its cost. Our military should heed the marketing and product-planning specialists who tell us that utility for the user and not technical sophistication is the key to success. It would also be wise to remember George Santayana's words, "Those who cannot remember the past are condemned to repeat it."

Jon Titus

Jon Titus
Editor

NEC ACTION MESSAGE

Streamline your driver and switching circuits.

With NEC's new power MOS FETs. Featuring 4V gate-source bias, low on-resistance and reduced chip size.

4V-driven power MOS FETs.

I_D (A)	V_{DSS} (V) Package	30	60	100
0.5	TO-92	2SK679 (0.5Ω)		
1.0	SOT-89	2SK680 (0.5Ω)		
	SP-8	2SK681 (0.5Ω)		
	MP-3			2SK611 (3.0Ω) 2SK654 (1.3Ω)
2.0		2SK738 (0.11Ω) 2SK801 (0.2Ω) 2SJ132 (0.25Ω)	2SK739 (0.17Ω) 2SJ133 (0.45Ω)	2SK612 (0.3Ω) 2SJ128 (0.8Ω)
	MP-5	2SK802 (0.2Ω)	2SK700 (0.6Ω) 2SK701 (0.4Ω)	2SK699 (0.8Ω)
5	MP-25 MP-45*		2SK704 (0.11Ω) 2SK705 (0.11Ω)*	2SK702 (0.2Ω) 2SK703 (0.2Ω)* 2SJ135 (0.25Ω)*
6				2SJ134 (0.25Ω)
10			2SJ137 (0.25Ω)*	2SJ139 (0.18Ω)*
12			2SK659 (0.05Ω)* 2SJ136 (0.25Ω)	2SK737 (0.1Ω)* 2SK811 (0.1Ω)* 2SJ138 (0.18Ω)
13			2SJ141 (0.15Ω)*	2SJ142 (0.15Ω)*
14				2SK810 (0.1Ω)
15			2SK591 (0.035Ω)*	2SK736 (0.08Ω)*
16			2SJ143 (0.11Ω)*	
19			2SJ140 (0.15Ω)	
21			2SK813 (0.06Ω)*	2SK815 (0.06Ω)*
26			2SK817 (0.035Ω)*	
27			2SK812 (0.06Ω)*	
40	MP-85		2SK835 (0.014Ω)	2SK836 (0.025Ω)
	MP-88		2SK797 (0.014Ω)	2SK798 (0.025Ω)

R_{DS}(on) typ, V_{GS}=10V

High-voltage, low on-resistance power MOS FETs.

I_D (A)	V_{DSS} (V) Package	250	450	500	900
3	MP-25 MP-45				2SK786 (6.0Ω) 2SK946 (4.5Ω)
4	MP-85 MP-88				2SK832 (3.2Ω) 2SK871 (4.5Ω)
5	MP-25 MP-80 MP-88		2SK854 (1.0Ω)	2SK855 (1.1Ω)	2SK719 (3.2Ω) 2SK833 (3.2Ω)
6	MP-88				2SK872 (2.0Ω)
8	MP-85 MP-88		2SK873 (0.9Ω)	2SK874 (1.0Ω)	2SK834 (1.2Ω) 2SK787 (1.25Ω)
10	MP-88		2SK735 (0.6Ω)	2SK819 (0.65Ω)	
12	MP-80 MP-85 MP-88		2SK799 (0.4Ω) 2SK824 (0.4Ω) 2SK875 (0.5Ω)	2SK773 (0.47Ω) 2SK828 (0.47Ω) 2SK876 (0.6Ω)	
15	MP-85 MP-88		2SK826 (0.32Ω) 2SK825 (0.4Ω)	2SK830 (0.35Ω) 2SK829 (0.47Ω)	
18	MP-80 MP-85 MP-88	2SK820 (0.18Ω)	2SK800 (0.32Ω) 2SK837 (0.25Ω) 2SK827 (0.32Ω)	2SK774 (0.35Ω) 2SK838 (0.3Ω) 2SK831 (0.35Ω)	
20	MP-80 MP-88	2SK720A (0.18Ω) 2SK821 (0.18Ω)	2SK784 (0.25Ω)	2SK785 (0.3Ω)	
22	MP-85	2SK822 (0.12Ω)			
25	MP-80 MP-88	2SK707 (0.12Ω) 2SK823 (0.12Ω)			

R_{DS}(on) typ, V_{GS}=10V

SOT-89

TO-92

MP-3

MP-3-Z

MP-5

MP-25

MP-45

MP-80

MP-85

MP-88

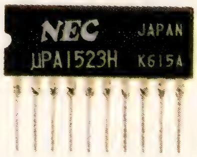
4V-driven power MOS FET arrays.

I_D (A)	V_{DSS} (V) Package	30	60	80	100
2	10-pin SIP	μPA1520H (0.11Ω)	μPA1522H (0.17Ω)		μPA1526H (0.3Ω)
		μPA1570H (0.3Ω)	μPA1572H (0.4Ω)	μPA1524H (0.6Ω)	μPA1576H (0.8Ω)
			μPA1523H (0.4Ω)		μPA1527H (0.8Ω)
5			μPA1552H (0.11Ω)		μPA1556H (0.2Ω)

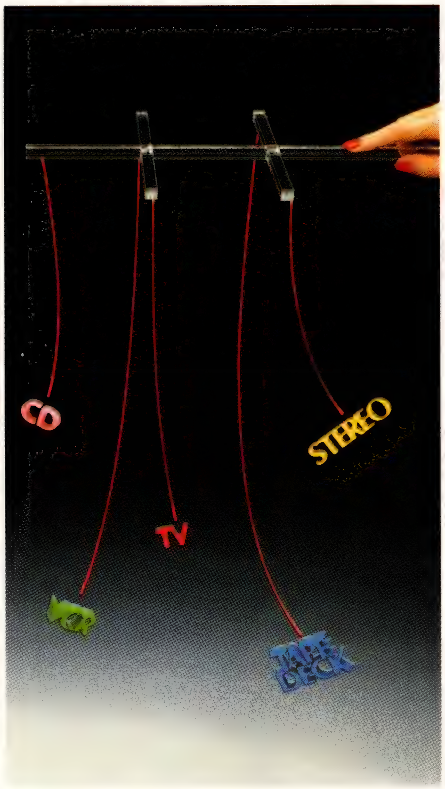
R_{DS}(on) typ, V_{GS}=10V

SP-8

10-pin SIP



C&C
Computers and Communications



Control the whole program.

NEC's programmable remote control transmitter ICs give you total control of home entertainment centers.

When king consumer kicks back, he wants total control over all the electronic entertainers in his castle. He wants TV, VCR, video disc, stereo, tape deck and CD all under the power of his magic wand. And means you need NEC's fully programmable ICs inside your infrared remote control transmitter.

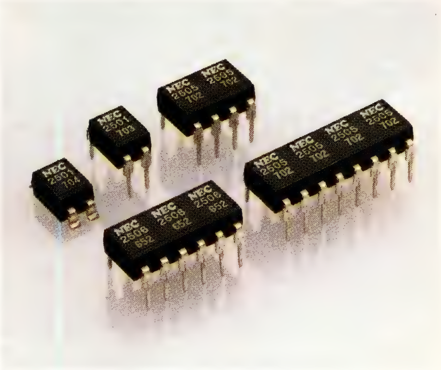
Powerful 4-bit application-specific microcomputers, the μPD6125 and 6126 are optimized for multi-function remote control units. They let you program transmission format freely and choose between 38kHz or 57kHz carrier frequency.

They have ample capacity to handle all components. With 64 key inputs for the 6125. And 96 for the 6126. Both feature 1K×10-bit ROM, 32×4-bit RAM, space-saving packages and low-power CMOS technology. Supply voltages range from 2V to 6V.

UNIFY YOUR SYSTEM.

A powerful remote control unit not only turns components on. It turns consumers on. It helps unify all the separate parts of your system into an irresistible whole. Find out how easy it is to control a larger share of the home entertainment market. With NEC's fully programmable remote control transmitter ICs.

Multi-channel photocouplers feature AC-input, high V_{CEO} and high CTR.



When your circuits need AC-input, high V_{CEO} or high CTR, just call NEC. We have the right multi-channel photocoupler design for you. We offer four series, each with 1-, 2-, 3- and 4-channel types. All come in DIPs for high-density mounting. Lead-forming types are also available for surface mounting. Ensure ample isolation for your densely-populated boards with NEC's family of high-performance, multi-channel photocouplers.

Multi-channel photocouplers

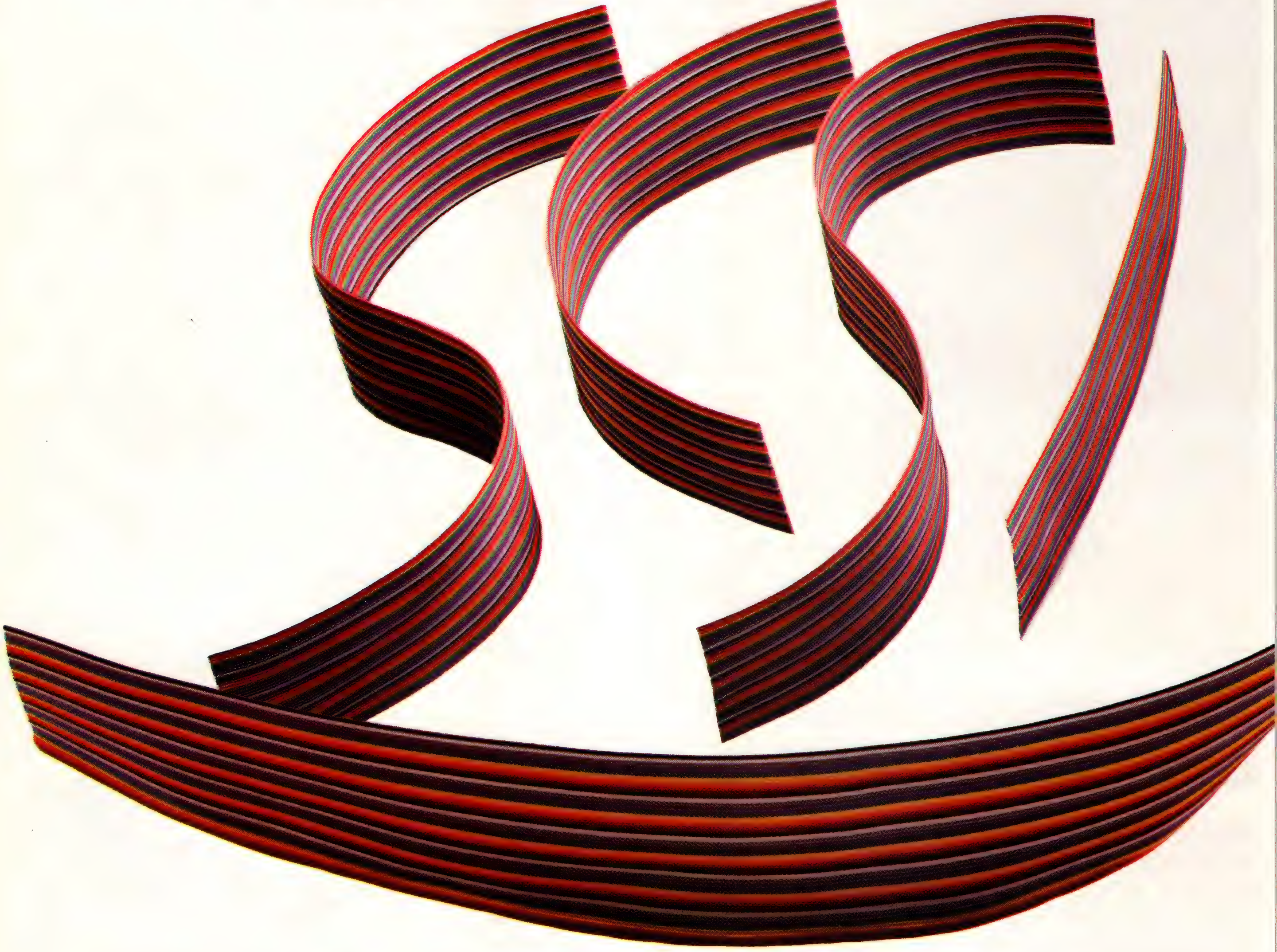
Device	I_F (mA)	V_{CEO} (V)	I_C (mA)	BV (kV)	CTR (%, typ)	Feature	Package
PS2501-1, -2, -3, -4	80	80	50	5 AC	300		4-, 8-, 12-, 16-pin DIP
PS2502-1 PS2502-2, -3, -4	80	40	200 160	5 AC	2,000		4-, 8-, 12-, 16-pin DIP
PS2505-1, -2, -3, -4	80	80	50	5 AC	300	AC Input	4-, 8-, 12-, 16-pin DIP
PS2506-1 PS2506-2, -3, -4	80	40	200 160	5 AC	2,000	AC Input	4-, 8-, 12-, 16-pin DIP

For further information, please contact:

■ **USA**		**Tel:1-800-632-3531. In California: Tel:1-800-632-3532. TWX: 910-379-6985.**
■ **Europe**	**W. Germany**	**Tel:0211-650302. Telex:8589960 NE D.**
	The Netherlands	**Tel:040-445-845. Telex:51923 NEC B NL.**
	Sweden	**Tel:08-732-8200. Telex:13839 NECSCAN S.**
	France	**Tel:1-3946-9617. Telex:699499 NEC EF.**
	Italy	**Tel:02-6709108. Telex:315355 NECEIT I.**
	UK	**Tel:0908-691133. Telex:826791 NECUK G.**
■ **Asia**	**Hong Kong**	**Tel:3-755-9008. Telex:54561 HKNEC HX.**
	Taiwan	**Tel:02-522-4192. Telex:22372 HKNEC TP.**
	Singapore	**Tel:4819881. Telex:39726 NECES RS.**
■ **Oceania**	**Australia**	**Tel:03-267-6355. Telex:AA38343 NECBCD.**

NEC

WE PUT A GREAT INTERFACE

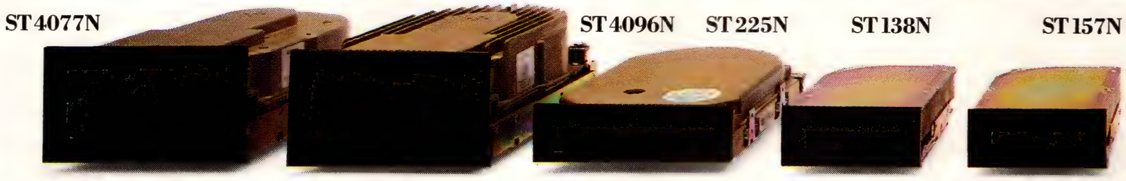


As an intelligent interface for small computers, SCSI has become a great standard, supporting multiple peripherals on a single cable.

Seagate supports that standard with the widest variety of SCSI hard disc drives available: 3½″ and 5¼″. Half-heights and full-heights. With capacities from 20 to 160 MB.

Seagate's SCSI drives have built-in features that give your products these advantages:

- Superior performance through higher transfer rates.
- Greater system throughput with overlapped operations, low command overhead and defect management that is automatic and transparent.
- Improved data integrity with enhanced recovery techniques.



WHERE IT DOES THE MOST GOOD.

- Superior reliability due to fewer cables, connectors and components.
- Increased flexibility with a choice of command sets: common (CCS) or customer-defined.
- Direct hardware connections to computers with built-in SCSI ports.
- Simple PC installation with our ST01 host adaptor.

Customers have come to expect this attention to performance, quality and reliability from Seagate. That's why they've bought more than 6 million of our hard disc drives.

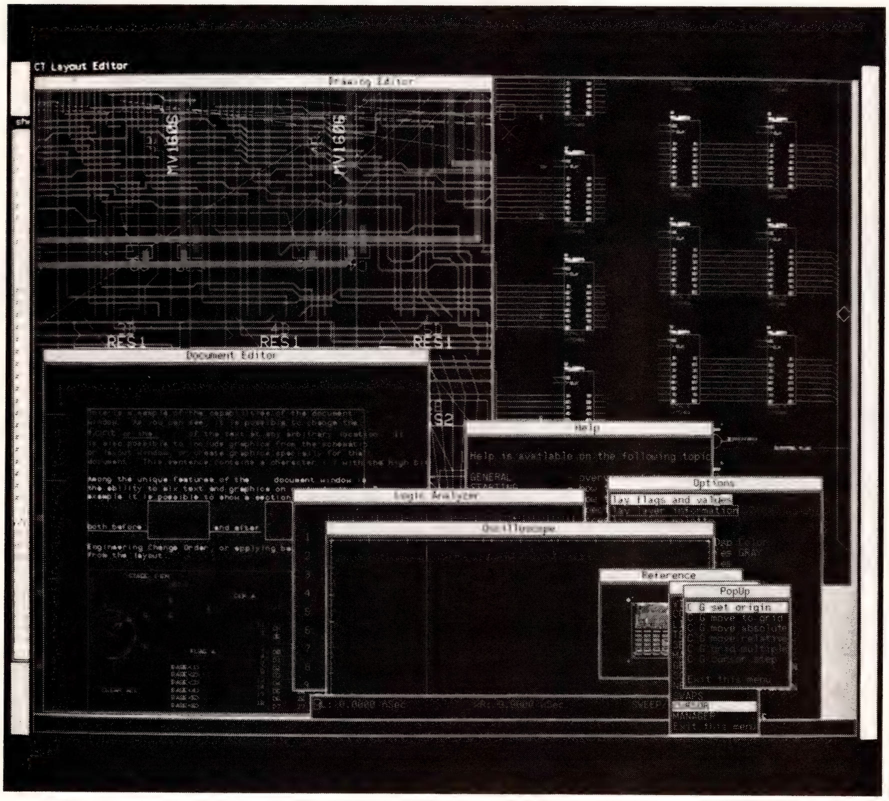
If you want to put great drives with a great interface in your system, call us. 800-468-DISC. In California, 800-468-DISK. Or write: Seagate Technology, 920 Disc Drive, Scotts Valley, CA 95066.

Seagate

The first name in disc drives.

CIRCLE NO 166

Windowed operating environment for CAE spans a variety of computer systems



Providing a complete set of CAE tools in a windowed environment, *the Vanguard Stellar CAE Design System incorporates an ASCII database that lets you move information from one window to other windows.*

The Vanguard Stellar CAE design system integrates a complete CAE tool set in a graphical shell that provides a windowed operating environment. This environment allows complete design-file compatibility among the various tools.

The tool set includes a schematic-design system, a symbol editor, a layout editor, an autorouter, a design-rule checker, an electrical-rule checker, analog and digital simulators, and a document editor. All these tools communicate with one another via an ASCII database.

The Stellar system works on many computers, but the operation of the system is identical on all the computers. Once you've learned how to use the system on an IBM PC/AT, you'll know how to use it on a Sun/3 workstation, a VAX, or a Microvax II GPX workstation.

The ASCII database resides at the core of the system. Each of the tools works with and creates ASCII files, so you can transfer data among tools. For example, you can transfer a section of a schematic to a document or, by pointing at the schematic, you can tell a simulator which node in a circuit you would like to view.

To communicate with other vendors' simulation tools, the Stellar system uses the CSDF (Common Simulation Data Format) for data transfer. This format is not yet an industry-wide standard, but many simulator vendors are embracing the CSDF. At present, the system can communicate with Silos, Cadat, PSpice, Spice, and Hilo.

To interpret the results of your simulation, you use a simulation window that lets you view the results on screens similar to those of logic analyzers or oscilloscopes.

The document editor provides a simple mixed text-and-graphics capability for engineering documentation, and it supplies interfaces to desktop-publishing packages such as Ventura and Interleaf. Having direct access to other engineering documents such as schematics, pc-board layouts, and simulation results greatly simplifies the task of creating high-quality documentation.

The commands are very similar from one tool to the next. It's not necessary for you to relearn the use of each tool as you progress in the design cycle. Also, each tool has a simple 7-command mode that allows you to tackle many tasks without having to master the full complexity of the system.

The system can interface to CAD tools and proprietary equipment such as automatic test equipment. The price of the Vanguard Stellar CAE Design System ranges from $15,900 for a PC/AT-based system to $50,000 for a VAX-based system. The company expects to begin shipping systems within 60 days.

—David Shear

Case Technology Inc, 2141 Landings Dr, Mountain View, CA 94043. Phone (415) 962-1440. TLX 506513.

Circle No 576

ZILOG

Z280

The highest performance and highest integration, ever. Together on a single 16-bit chip.

The Z280™ gives you a more powerful CPU and higher performance peripherals than you've ever seen on a 16-bit chip. Think of it as a complete microsystem on a chip.

Unmatched performance...

Start with the most powerful 16-bit engine available, add on-board Cache, MMU and Burst Mode memory support — and you'll begin to understand the Z280's power and potential.

...powerful on-board peripherals...

Imagine the savings in cost and board size when you have peripherals like 4 DMA channels that'll give you transfers at 6.6 Mbytes/sec, and a full-duplex UART.

	Z280™	80186	68070
Package	68-pin PLCC/CMOS	68-pin LCC/NMOS	84-pin PLCC/CHMOS
Typical Power	375 mW	2 W	800 mW (est)
Speed	10-25 MHz	8-12.5 MHz	10 MHz
Memory Support	16 Mb Physical Paged	1 Mb Physical Segmented	16 Mb Physical 8 or 128 Segments
16-bit Registers	12 General	8 General	15 Dedicated
Instruction Pre-fetch	256-Byte Assoc. Cache; Burst Mode	6-Byte Queue	None
Multiprocessor Support	Local or Global	Local only	Local only
Wait Logic	Programmable	Programmable	Hardwire
DMA	4 Channels, 6.6 Mb/s @ 10 MHz	2 Channels 2 Mb/s @ 8 MHz	2 Channels, 3.2 Mb/s @ 10 MHz
Counter/Timers	3 16-bit	3 16-bit	2 16-bit
Serial I/O	1 Full-Duplex UART	None	1 Full-Duplex UART
DRAM Controller	10-bit Refresh	None	None
Price (100)	$33	$43	$50

The choice is clear.

...and the glue to tie it all together.

With a DRAM Controller to support up to 1 MBit DRAMs and Programmable Wait State Logic — on board — you're really looking at significant glue reduction.

Z280: Truly a microsystem.

The Z280 gives you a lot more performance. In a lot less board space. All off the shelf and backed by Zilog's proven quality and reliability. Plus, it's binary code-compatible with the Z80,® and priced to rival 8-bit chips. And all the development support tools you need are available from industry leaders. Contact your local Zilog sales office or your authorized distributor today. Seeing is believing. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008 (408) 370-8000.

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CIRCLE NO 178

WHY CHOOSE A ZAX EMULATOR WHEN DEVELOPING WITH HITACHI, MOTOROLA, NEC OR INTEL?

Unparalleled support for true emulation of their microprocessors! Emulation that places you in control of beating your microprocessor design deadlines. User-convenient emulation that makes your job a lot easier.

ZAX offers a broad range of in-circuit emulators conceived, designed and tested to meet your development needs. Emulators for NEC's V40/V50, Intel's 8051/8052 family of microcontrollers, Motorola's 68000/10 and our *newest* emulators for Hitachi's 6301 and 64180 series. Additionally, we support Z80, 6809/E, 8086/88 & 80186/188, V20/V30 microprocessors and the 8048 family of microcontrollers.

All ZAX Emulators contain an internal processor, "loanable" RAM and extensive debugging mechanisms. They function in real-time and are rated at the same clock speed as the manufacturer's processor. The emulators introduce no added wait states so the prototype program can be executed exactly as the processor would and in the same length of time.

Unparalleled software support is also provided by ZAX. We offer extensive interface and development software for our emulators. All ZAX Emulators interface to a variety of host computers via the optional ZAX-developed communications utility ZICE-II. For development software access, we offer a broad range of products including "C" & Pascal compilers, cross assemblers/loaders and object module librarians.

And should you need a wholly supported host computer, look no farther than ZAX. The ZAX BOX-ER is an economical host computer that's easy to use, delivers abundant processing power, possesses superior memory capacity and supports high resolution graphics for engineering applications. The perfect complement to our emulators.

At ZAX, we're committed to providing you with the tools you need to beat your microprocessor design deadlines. All of our products are backed by a full, one-year warranty which protects you from unnecessary delays. So, whether you're engaged in development using a microcontroller or a variety of microprocessors, call us and we'll show you why you *need* ZAX's Unparalleled Support.

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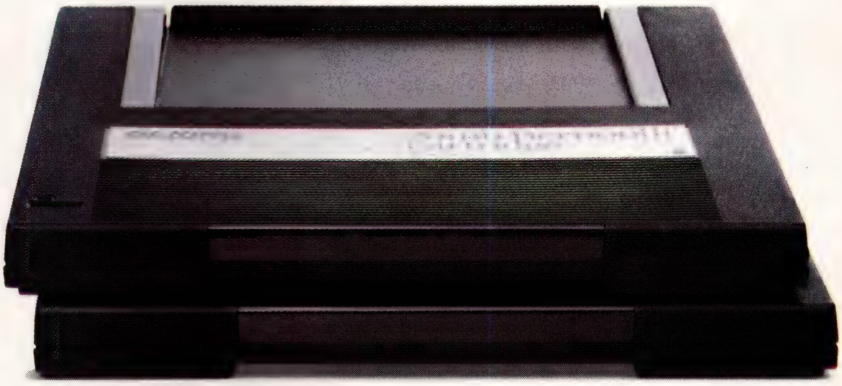
ZAX

Zax Corporation

CIRCLE NO 179

You don't have to go to great heights to get great volume.

40MB



40MB

HP users, take heart.

Tired of shuffling through a stack of floppies to find your latest computer project?

Great. You've come to the right place.

With just one of our Bering Bernoulli cartridges, you can get a whopping 20MB of removable storage.

That's 25 times the storage you can get from a standard floppy. Or, about the same storage you can expect from one hard disk.

Which means our HP compatible storage systems can do much for those who need high capacity.

But that's just for openers.

Because Bernoulli cartridges are removable, you can take them anywhere. Or leave them right in your office.

You can lock them away in a safe. Or keep them from falling into the wrong hands. Something that's rather difficult to do with a hard disk.

Since a Bernoulli drive offers unlimited capacity, you won't run out of storage space the way you do with floppies or hard disks.

You won't have to worry about desk clutter, either.

And when it's time to backup your data, you simply slide in another cartridge. It's that simple.

Furthermore, Bernoulli aerodynamics result in less wear and a longer life for both drive and media.

So whether you're an HP9000 (Series 200/300/500), HP1000, HP3000 or Integral PC user, our high performance drives provide a complete solution for primary and backup storage.

For instance, you can get a dual 20MB TwinPac (5840-RM) or a single 20MB UniPac (5820-RM) removable drive.

Both are fast, reliable, versatile and removable.

For higher capacities, our MultiPac drives feature a Bernoulli 20MB drive and a hard disk in one convenient package. Our 5204 model has a 40MB hard disk for a 60MB total drive. And our 5205 model includes a 57MB drive for those requiring a 77MB system.

Naturally, there's a lot more to know about our drives. So if you're interested, and you'd like more information, call or write today. It's a great way to go.

Bering Industries, Inc., 280 Technology Circle, Scotts Valley, CA 95066. Inside California, call **800 533-DISK.** Outside California, call **800 BERING 1.**

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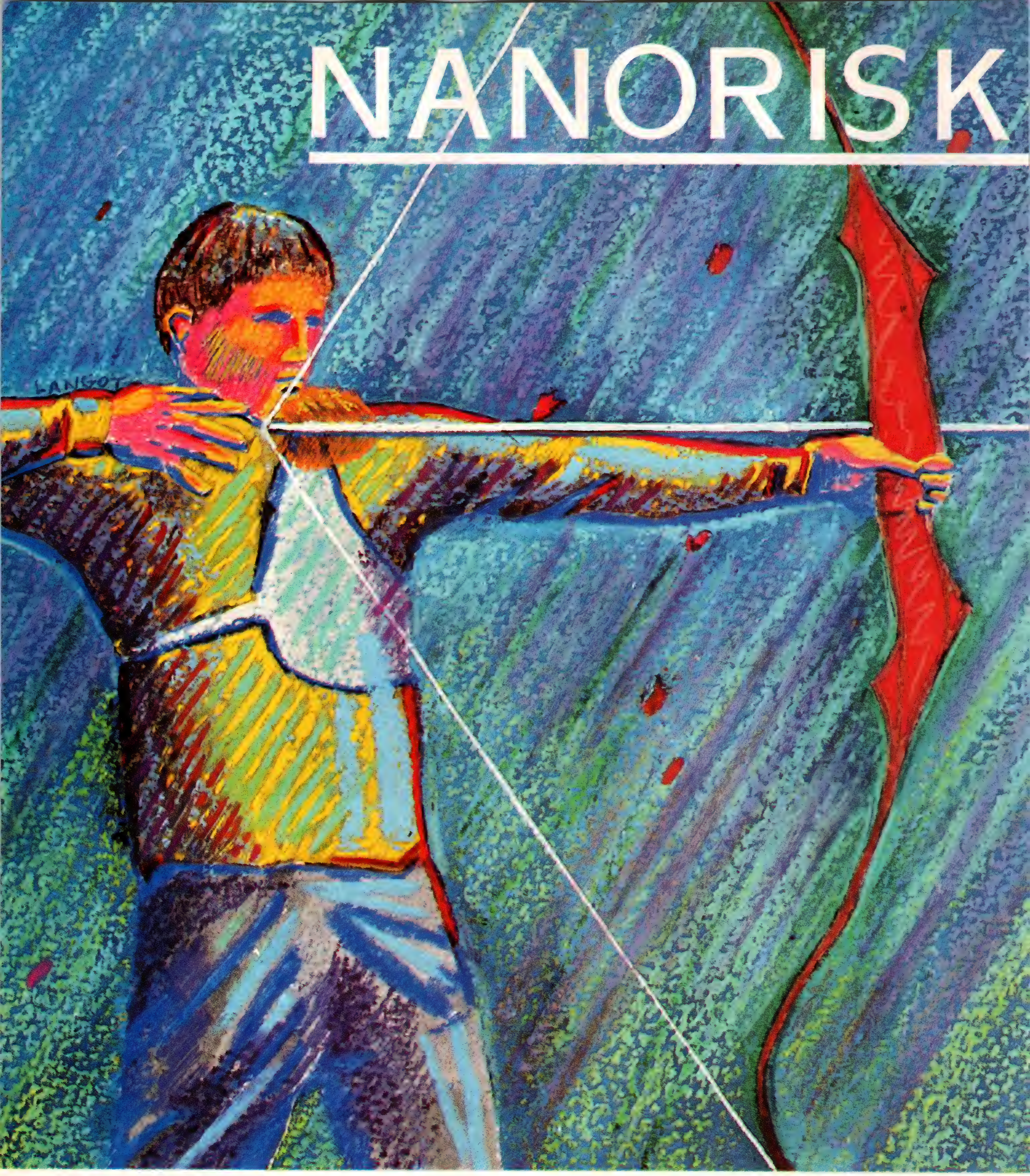
CIRCLE NO 131



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Nanomask : a financial structure resting on private venture capital companies, is and will always be your guarantee of independence and confidentiality.

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CIRCLE NO 55

SIEMENS

High performance for low-current applications

Miniature relay D2

Siemens offers a highly extensive range of tried and tested electromechanical components, plus all the experience of a manufacturer who has consistently invested a great deal of know-how in developing and perfecting electromechanical components geared to market requirements.

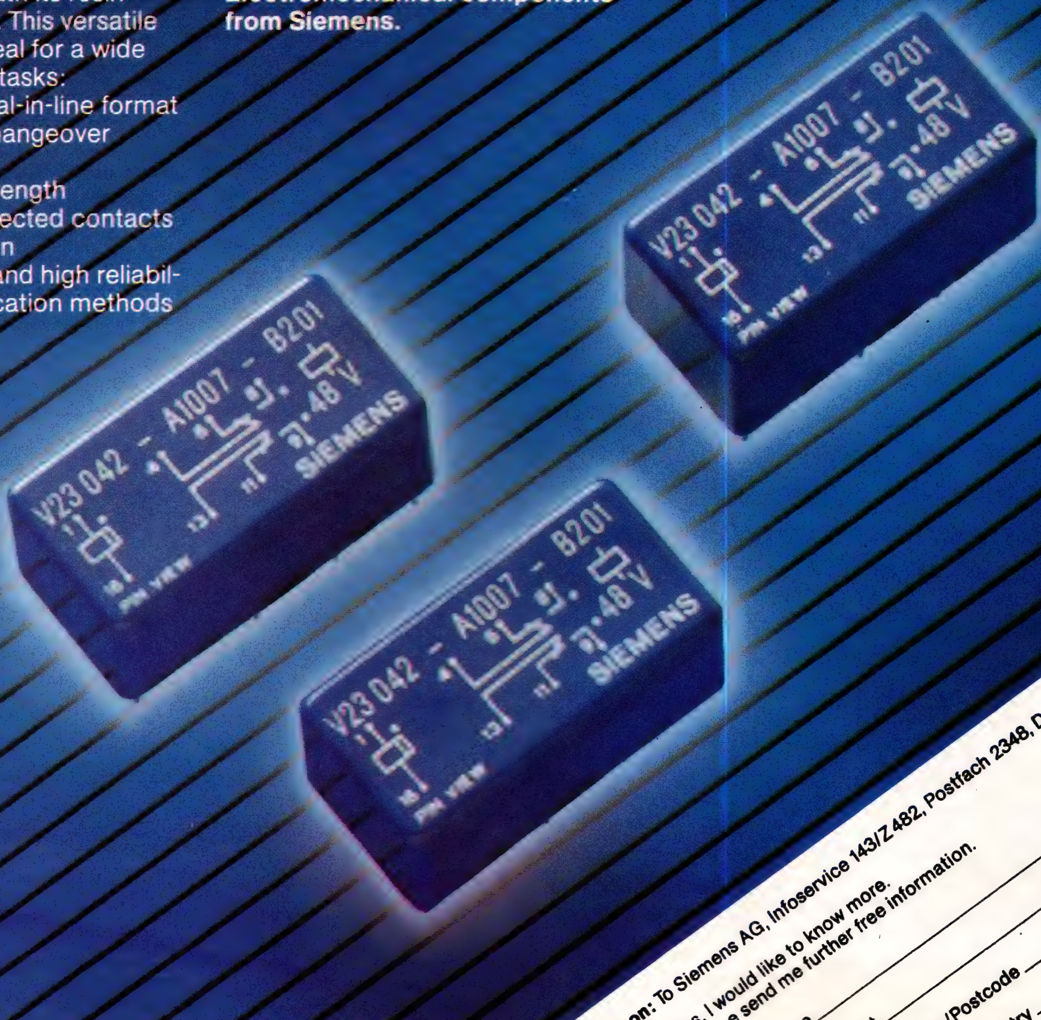
The miniature relay D2 is a typical example. Intelligent technology lies encapsulated beneath its resin-sealed plastic cover. This versatile relay is therefore ideal for a wide variety of switching tasks:

- Terminals with dual-in-line format
- Fitted with two changeover contacts
- High dielectric strength
- Atmosphere-protected contacts
- Slideless actuation
- Long service life and high reliability due to new fabrication methods

This makes the miniature relay D2 the universal interface device in every field of communication engineering.

All the other features of the miniature relay D2 are detailed in a special publication. If you would like one, please use this journal's reader service or send us the coupon.

Contacts you can rely on. Electromechanical components from Siemens.



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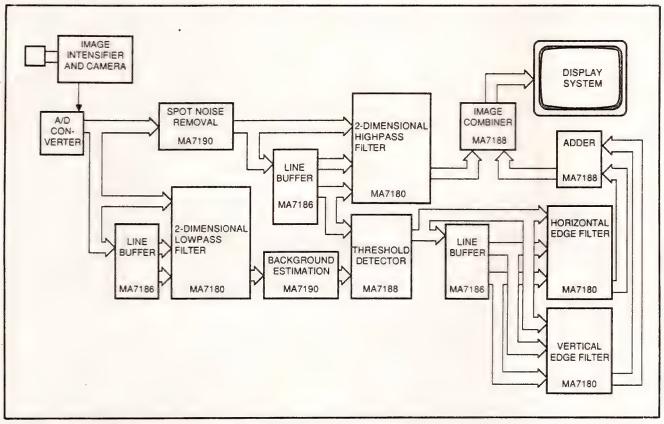
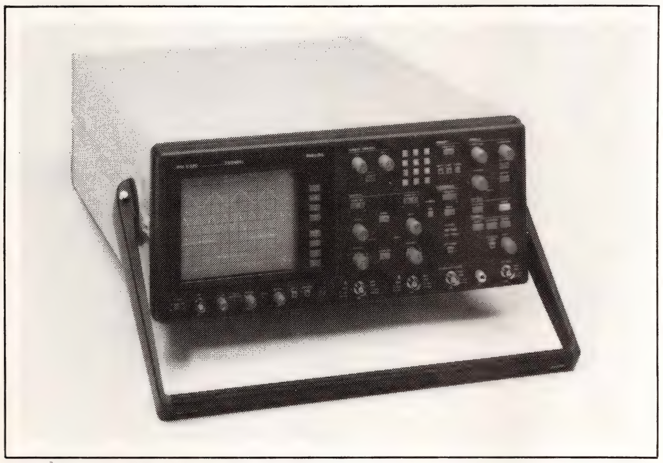
READERS' CHOICE

Of all the new products covered in EDN's **April 30, 1987**, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **April 30, 1987**, issue.



▲ DSP CHIPS

The MA7100 Signal Stream DSP chips handle 10-bit data at throughput rates as high as 20M samples/sec, allowing you to build DSP systems with a dynamic range of 60 dB and a bandwidth of 10 MHz (pg 103).
Marconi Electronic Devices Ltd.
Circle No 450
Marconi Electronic Devices Inc.
Circle No 451

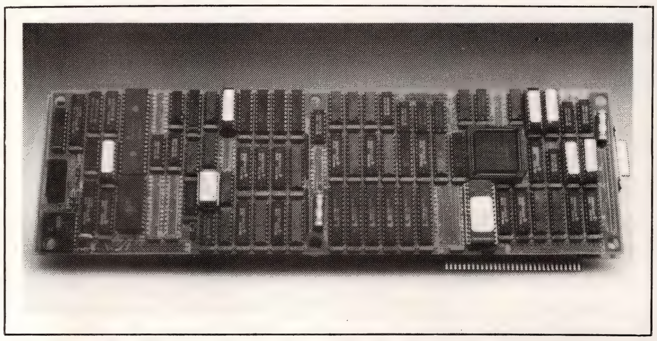


▲ OSCILLOSCOPE

The PM3320 digital storage oscilloscope provides an equivalent analog bandwidth of 200 MHz for repetitive waveforms; in single-shot mode, it captures a minimum of 512 input samples at 4-nsec intervals (pg 108).
Philips, Industrial and Electroacoustic Systems Div.
Circle No 452
Philips Test & Measuring Instruments Inc.
Circle No 453

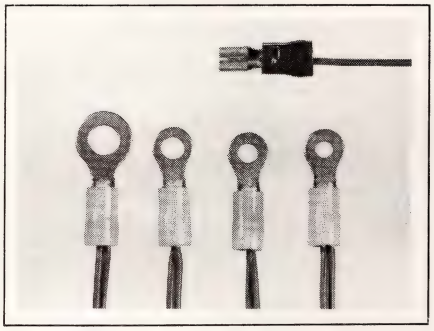
CAD FOR MACINTOSH

SpaceEdit is a 2- and 3-D CAD software package that runs on an Apple Macintosh equipped with 512k bytes of memory (pg 270).
Abvent.
Circle No 454



▲ GRAPHICS CONTROLLER

The 1004 display controller offers 16 colors from a palette of 4096 and has a screen resolution of 1024×768 dots (pg 256).
Metheus Corp.
Circle No 456



▲ SENSORS

The Thermamount surface-mount ring sensors operate over a -55 to $+150^\circ C$ range. These NTC thermistors operate unattended and are fully recyclable (pg 250).
Piezo Electric Products Inc.
Circle No 455

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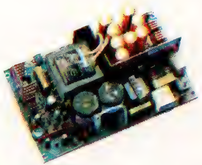

Sierra Power Systems
Division of Valor Electronics, Inc.

CIRCLE NO 99

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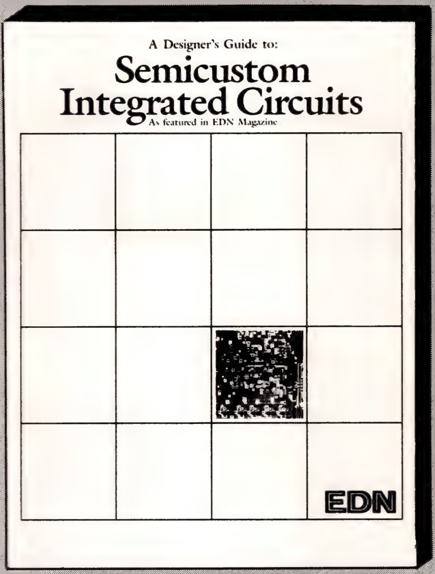

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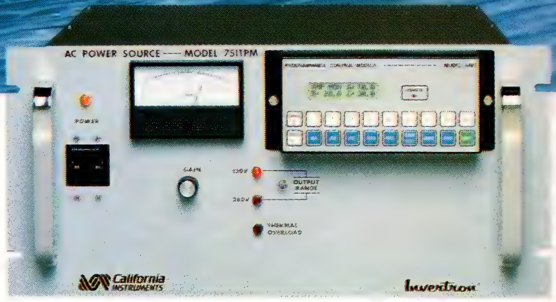

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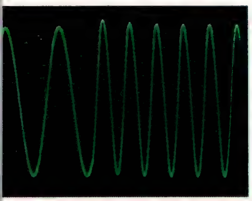
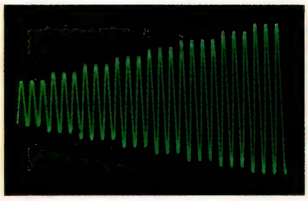
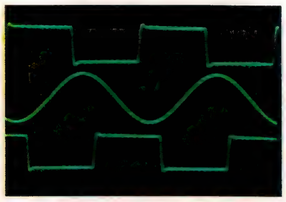
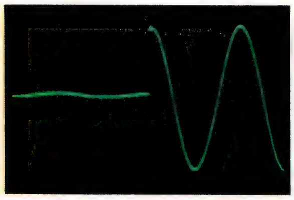
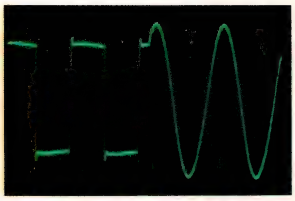

rogrammable Frequency


Amplitude Ramp/Step


Multi-Phase Waveforms


Programmable Start-Point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CIRCLE NO 137

LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	0	11	61	28	0	0	9.5	10.7
Pot-Core	0	13	67	20	0	0	8.8	11.4
Laminate (power)	5	24	62	9	0	0	7.1	9.6
CONNECTORS								
Military panel	8	8	34	50	0	0	10.7	13.3
Flat/Cable	10	45	35	10	0	0	5.7	5.9
Multipin circular	0	19	37	44	0	0	10.3	9.7
PC	17	33	39	11	0	0	5.8	6.5
RF/Coaxial	12	29	29	18	12	0	9.0	7.1
Socket	32	26	21	21	0	0	5.7	6.2
Terminal blocks	12	60	20	8	0	0	4.6	5.3
Edge card	6	35	47	12	0	0	6.6	9.2
Subminiature	15	25	35	20	0	5	8.2	6.3
Rack & panel	18	37	18	18	9	0	7.7	7.2
Power	20	20	20	40	0	0	8.4	11.1
PRINTED CIRCUIT BOARDS								
Single-sided	0	65	30	5	0	0	5.1	6.3
Double-sided	0	32	64	4	0	0	6.7	6.8
Multilayer	0	12	71	17	0	0	8.7	8.6
Prototype	4	83	9	4	0	0	3.8	4.8
RESISTORS								
Carbon film	55	19	13	13	0	0	3.6	4.6
Carbon composition	32	28	28	12	0	0	4.9	6.5
Metal film	33	37	19	11	0	0	4.3	5.5
Metal oxide	43	29	21	7	0	0	3.7	6.1
Wirewound	14	41	35	10	0	0	5.6	7.1
Potentiometers	14	33	30	20	3	0	7.4	7.4
Networks	16	37	37	10	0	0	5.7	7.3
FUSES	38	33	25	4	0	0	3.6	3.8
SWITCHES								
Pushbutton	21	42	29	8	0	0	4.9	7.3
Rotary	0	39	39	22	0	0	7.7	8.3
Rocker	10	45	25	20	0	0	6.5	6.1
Thumbwheel	0	39	46	15	0	0	7.2	8.4
Snap action	7	57	22	14	0	0	5.6	6.2
Momentary	21	47	16	16	0	0	5.1	7.2
Dual in-line	0	55	27	18	0	0	6.6	6.9
WIRE AND CABLE								
Coaxial	25	40	30	5	0	0	4.4	4.3
Flat ribbon	20	40	30	10	0	0	5.2	3.7
Multiconductor	13	44	30	13	0	0	5.8	6.2
Hookup	42	39	15	4	0	0	3.0	3.3
Wire wrap	41	35	12	12	0	0	3.8	4.3
Power cords	21	38	33	8	0	0	5.1	4.9
Other	11	56	11	22	0	0	6.0	10.8
POWER SUPPLIES								
Switching	0	24	53	23	0	0	8.6	12.5
Linear	14	22	50	14	0	0	6.9	9.3
CIRCUIT BREAKERS	11	44	28	17	0	0	6.1	5.0
HEAT SINKS	14	36	41	9	0	0	5.8	5.3

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
General purpose	8	48	20	24	0	0	6.8	5.8
PC board	0	39	28	33	0	0	8.6	7.5
Dry reed	0	50	10	40	0	0	8.5	8.0
Mercury	0	37	27	27	9	0	9.8	8.3
Solid state	7	20	33	33	7	0	10.1	8.1
DISCRETE SEMICONDUCTORS								
Diode	30	27	28	15	0	0	5.3	5.7
Zener	27	33	23	17	0	0	5.5	5.8
Thyristor	0	43	28	29	0	0	8.0	8.5
Small signal transistor	17	50	6	27	0	0	6.3	6.7
FET, MOS	6	47	12	35	0	0	7.8	8.5
Power, bipolar	0	57	7	36	0	0	7.8	7.8
INTEGRATED CIRCUITS, DIGITAL								
CMOS	24	28	24	24	0	0	6.5	7.9
TTL	18	41	18	23	0	0	6.3	6.4
LS	23	36	18	23	0	0	6.1	6.1
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	0	58	17	25	0	0	7.0	8.7
OP amplifier	9	33	29	29	0	0	7.7	7.9
Voltage regulator	20	40	20	20	0	0	5.9	6.0
MEMORY CIRCUITS								
RAM 16k	23	31	8	38	0	0	7.5	7.1
RAM 64k	20	20	27	33	0	0	7.9	7.2
RAM 256k	12	38	25	25	0	0	7.0	6.3
ROM/PROM	21	14	29	36	0	0	8.3	6.6
EPROM	10	25	30	35	0	0	8.6	7.5
EEPROM	15	23	39	23	0	0	7.3	6.3
DISPLAYS								
Panel meters	13	53	20	14	0	0	5.3	8.2
Fluorescent	0	43	29	28	0	0	8.0	9.1
Incandescent	25	38	12	25	0	0	6.0	7.9
LED	22	30	30	15	0	3	6.7	7.4
Liquid crystal	0	21	22	50	0	7	12.3	9.1
MICROPROCESSOR ICs								
8-bit	6	31	25	38	0	0	8.8	9.0
16-bit	8	31	38	23	0	0	7.6	6.8
FUNCTION PACKAGES								
Amplifier	0	56	11	33	0	0	7.7	7.1
Converter, analog to digital	0	38	8	46	8	0	10.9	10.0
Converter, digital to analog	0	33	25	42	0	0	9.5	10.0
LINE FILTERS	0	45	22	33	0	0	8.3	8.5
CAPACITORS								
Ceramic	18	37	26	19	0	0	6.1	5.8
Ceramic monolithic	9	24	29	38	0	0	8.9	7.0
Ceramic disc	14	36	27	23	0	0	6.8	5.6
Film	4	46	18	32	0	0	7.8	9.8
Electrolytic	8	50	8	31	3	0	7.9	8.1
Tantalum	8	35	38	19	0	0	7.1	7.4
INDUCTORS	11	39	33	17	0	0	6.4	7.8

Source: *Electronics Purchasing* magazine's survey of buyers

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- ☐ *full DMA/MMU/Refresh emulation support*
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- ☐ *the Universal Development Station may be easily reconfigured for:*
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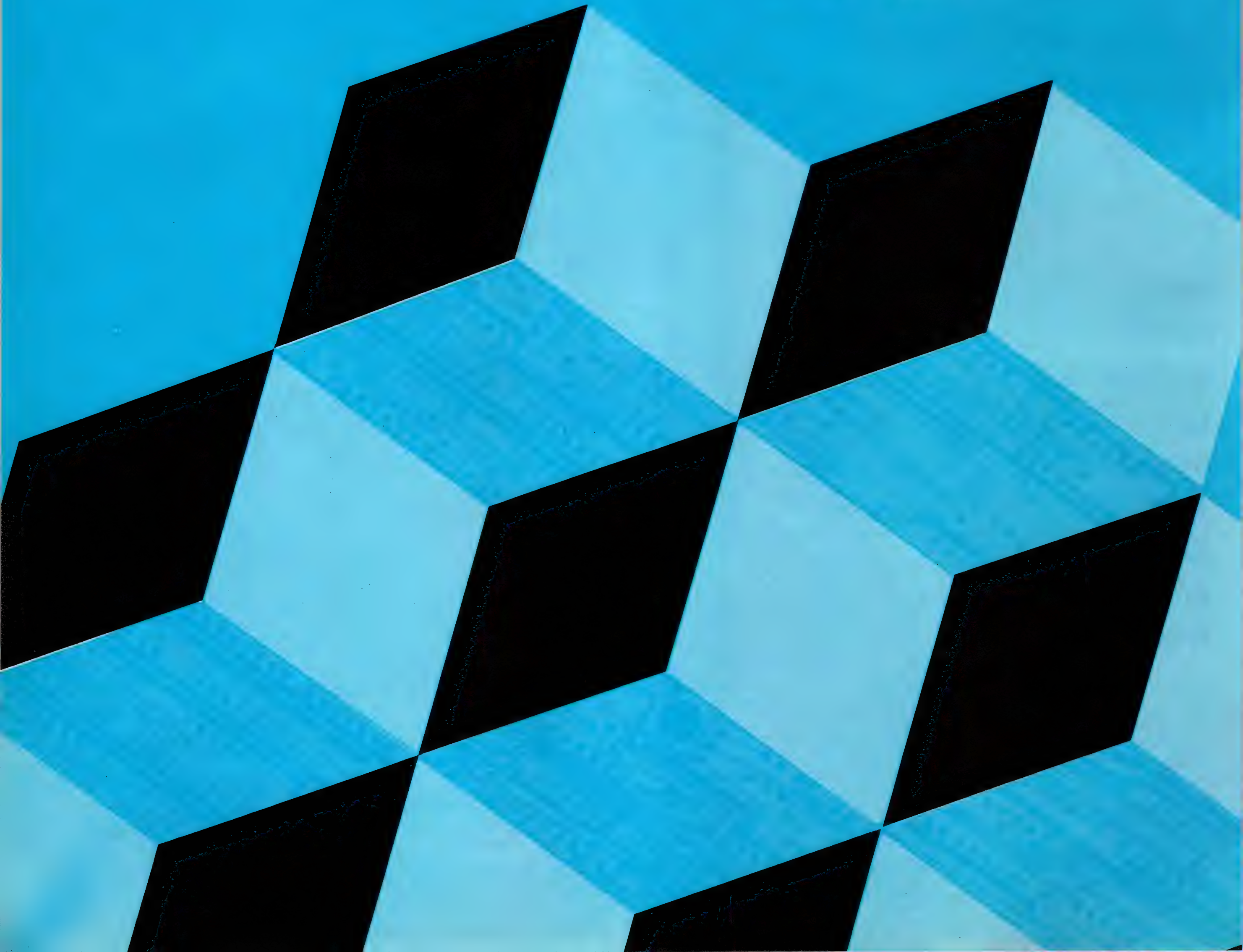

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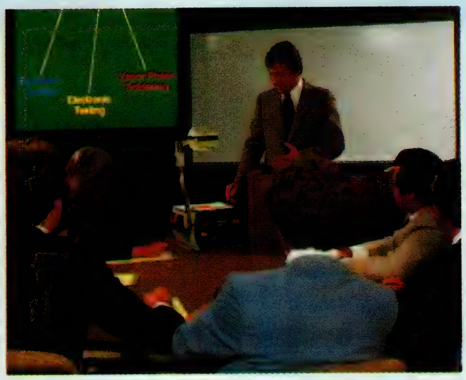

*Fluoronics Resources:

An exclusive 3M combination of innovative products backed by research and development, manufacturing expertise, technical data and service assistance built on more than 35 years' experience of pioneering in fluorochemistry.

3M has had a whole generation of experience in the development, manufacture and refinement of perfluorinated liquids. We first introduced these versatile liquids to electronics design, testing and production professionals in the fifties. Since then, Fluorinert Liquids have become the mainstays in electronic cooling, high reliability testing and vapor phase soldering.

Fluorinert Liquids, used as a direct contact heat transfer medium, offer a range of physical properties that make them particularly suitable for electronic uses. They are non-polar and exhibit no solvent action. They are colorless, low in toxicity, non-flammable and offer exceptionally high dielectric strength plus thermal and chemical stability. Most important, they have almost no chemical reactivity and they evaporate without leaving a residue on parts.

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Our FC™ numbers — FC-40, FC-70, FC-77, etc. — are used to identify Fluorinert Liquids that offer certain physical characteristics to meet specific application needs. These FC numbers are solely 3M designations for various fluorochemical products.

Fluorinert Liquids are being used cost-effectively in cooling, high reliability testing and vapor phase soldering operations. When you are interested in applying these versatile liquids in your own production, 3M can provide an abundance of technical information and support.

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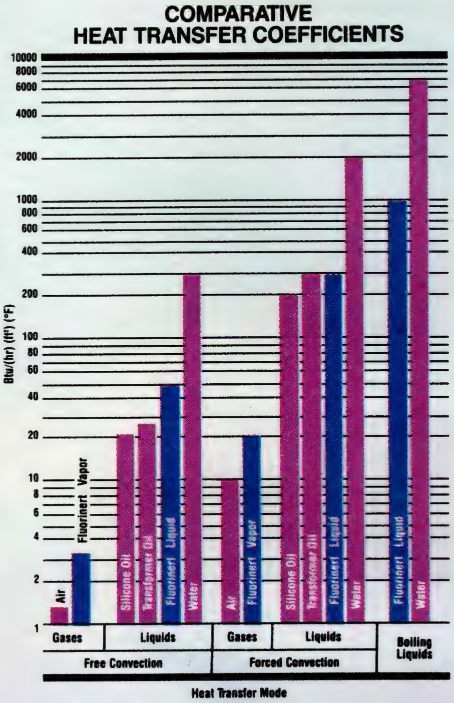
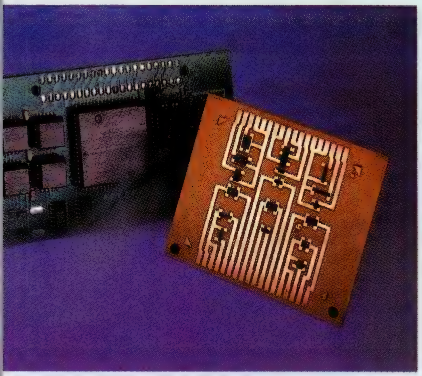


Fluorinert™ Liquids achieve accurate high reliability testing

It's a small world you work in. Where time ticks in nanoseconds and dimension is measured in Angstrom units. And as circuitry becomes more complex, a greater demand is placed on testing capability — not only in speed, but in higher reliability and accuracy.

Fluorinert Liquids meet those requirements by providing a controlled temperature environment and a high degree of electrical protection. They offer maximum compatibility between



the heat transfer medium and the device under test. Fluorinert Liquids reduce testing costs by reducing testing time substantially. They do this by rapidly reaching test temperature and providing precise and uniform temperature control. You'll minimize the number of faulty units by detecting defects before they become rejects.

These liquids provide cost-effective tests such as gross leak, thermal shock, liquid burn-in, ceramic crack detection, electrical environmental, temperature calibration and failure analysis/short detection.

Fluorinert Liquids are specified in the MIL-STD's for thermal shock and gross leak testing.

THERMAL SHOCK TEST CONDITIONS

Military Standard 883-1011			Military Approved Fluorinert Liquids	
Test Condition	**Hot Test Step 1**	**Cold Test Step 2**	**Hot Test Step 1**	**Cold Test Step 2**
A	100°C	– 0°C	Water , FC-40	Water , FC-40, FC-77
B	125°C	– 55°C	FC-40, FC-70, FC-5311	FC-77
C	150°C	– 65°C	FC-40, FC-70, FC-5311	FC-77
D	200°C	– 65°C	FC-70, FC-5311	FC-77
E	150°C	– 195°C	FC-40, FC-70, FC-5311	Liq. N_2
F	200°C	– 195°C	FC-70, FC-5311	Liq. N_2

GROSS LEAK TEST CONDITIONS

Military Standards	Military Approved Fluorinert Liquids		
	Indicator Fluids	**Detector Fluids**	**Absorption Fluids**
MIL-STD 883-1014	FC-40, FC-43	FC-72, FC-84	Do not apply
MIL-STD 750-1071	FC-40, FC-43	FC-72, FC-84	FC-43, FC-75, FC-77
MIL-STD 202-112	FC-40, FC-43	FC-72, FC-84	Do not apply

Discover higher yields in vapor phase soldering

Fluorinert Liquids have been the industry's fluid of choice since the vapor phase reflow soldering (VPS) process was introduced in 1975. There are a number of good reasons for this universal acceptance. VPS with Fluorinert Liquids produces highly reliable solder joints. The system reduces reject rates, increases production, and lowers production costs. With Fluorinert Liquids, you can be assured that your products will never be exposed to a temperature higher than the selected liquid's boiling point. (See above)

You'll avoid those problems usually associated with other systems — shadowing, uneven heating, and overheating. The liquids are non-flammable. Their low surface tension helps them evaporate quickly from the work pieces without leaving a residue.

VPS with Fluorinert Liquids is especially suited for boards with high mass or complex geometries. The liquid vapors completely surround the assembly and penetrate remote recesses to heat all surfaces evenly. The vapors are 15 to 20 times heavier than air so they can be contained easily within the work area. The system offers an oxygen-free, non-corrosive environment to minimize rejects from oxidation contamination.

Some typical applications using Fluorinert Liquids in VPS include surface mounted leaded or leadless components, through-hole leads and wire-wrap pins, lead frame attachment, reflow of electroplated solder or tin and miscellaneous metal joining.

VPS SELECTION GUIDE

Fluorinert Liquid	Boiling Point	Typical Solders
FC-43	174°C/345°F	70 Sn/18 Pb/12 In 100 In 58 Sn/42 In 58 Bi/42 Sn
FC-70, FC-5311 FC-5312	215°C/419°F	63 Sn/37 Pb 60 Sn/40 Pb 62 Sn/36 Pb/2 Ag
FC-71	253°C/487°F	100 Sn 95 Sn/5 Ag 60 Pb/40 Sn

Discover the unique cooling benefits of Fluorinert™ Liquids

As the package size decreases, your need for more efficient heat dissipation increases in proportion. 3M Fluorinert Liquids are very efficient as a direct contact heat transfer medium, with the added advantage of having the high dielectric characteristics needed to meet stringent demands of the diversified electronics industry. We offer 11 liquids with boiling points that range from 56°C to 253°C.

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- Radar klystrons • Computer modules
- Computer memories • Fuel cells

Typical properties of Fluorinert Liquids used in cooling are:

Fluorinert Liquid FC-77 (English Units)	Liquid		Vapor
	Room Temp. (77°F)	**Boiling Point (207°F)**	**Boiling Point 207°F @/ATM**
Density lb./ft^3	111	100	0.85
Thermal Conductivity Btu/(hr) (ft^2) (°F/ft)	0.037	0.033	0.008
Specific Heat Btu/(lb.) (°F)	0.25	0.28	0.23
Viscosity c.p.	1.42	0.46	0.02
Coefficient of Thermal Expansion ft^3/(ft^3) (°F)	0.0008	0.0009	0.0015

Discover heating/curing with Fluorinert™ Liquids

Because they maintain their vapor temperature with absolute precision, Fluorinert Liquids can be used in many heating and/or curing operations. They serve as heat transfer media in solder mask and polymer thick film applications and for polymer processing. The non-corrosive vapors will not support oxidation. Ideal where solvent flash-off is a problem.

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3M is now offering a series of "Applied Fluoronics" tapes demonstrating how Fluorinert Liquids are used in a number of applications. See first hand how these remarkable products can improve overall electronic production.

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3. "Applied Fluoronics: Direct Contact Cooling"

These informative VHS format tapes are available to qualified personnel in the electronics industry. Specify which cassette(s) you would like to view.

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CIRCLE NO 96

EDN's Hands-On SMT Project—Part 4

Assembling the surface-mount project board

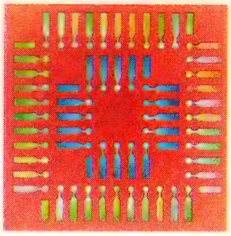
The fabricated pc boards arrived from the fabricator, and we departed for Texas to build our first SMT assemblies. There we ran into more "islands of automation," but our boards turned out to be relatively easy to assemble.

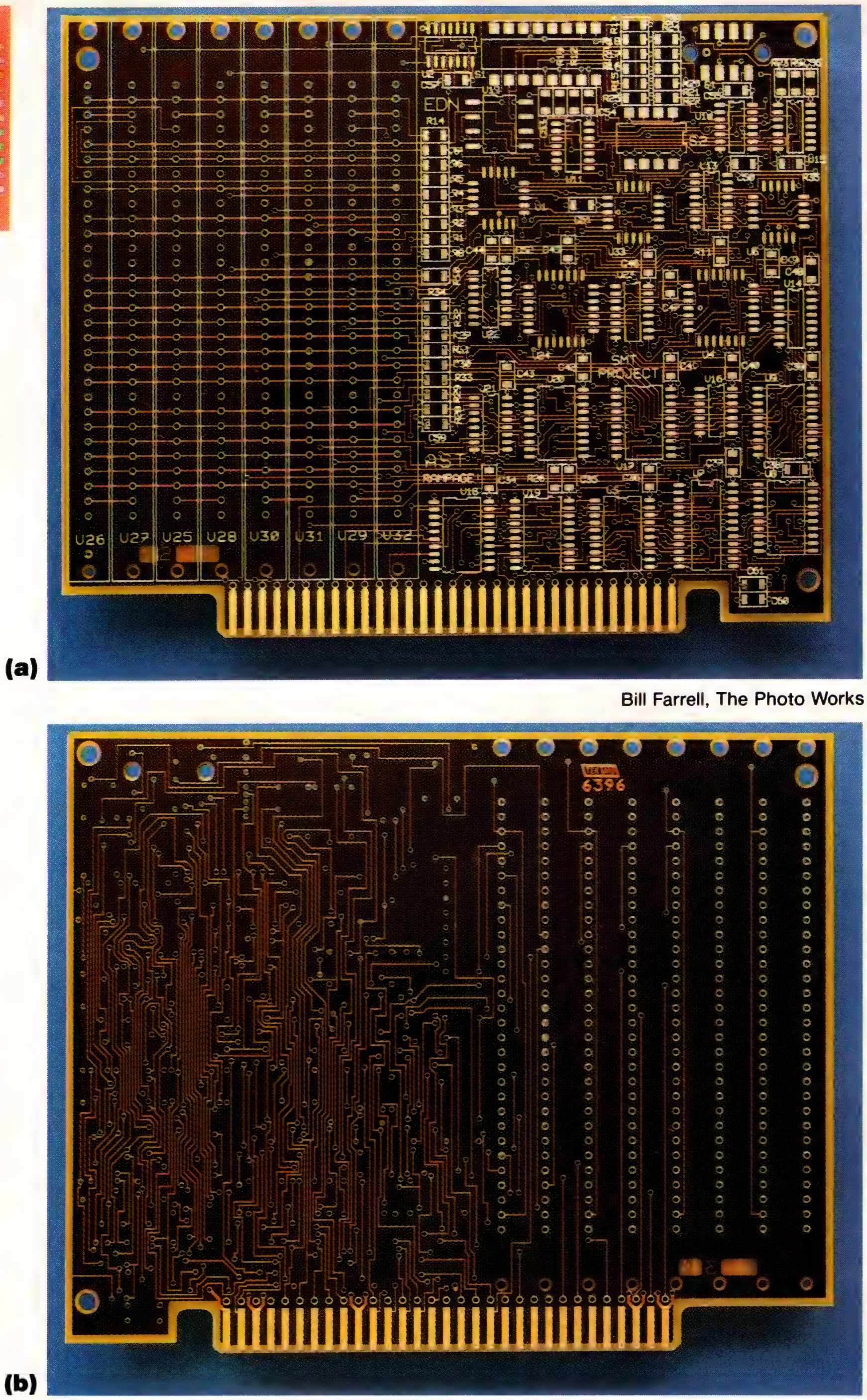
The boards were back in town. As we had hoped, the solder mask was glassy and smooth with nary a fold, bubble, or crack to be seen. Tektronix had done an excellent job, despite two aspects of our board design that made Tektronix's board fabrication a little more difficult than necessary (**Fig 1**).

From Tektronix's viewpoint as a pc-board vendor, we had placed vias too close to the edge-connector fingers. The proximity of the vias to the gold-plated fingers caused some of the gold solution to deposit inside the via holes, causing the vias to turn

Steven H Leibson, *Regional Editor*

Illustration by Michael Young





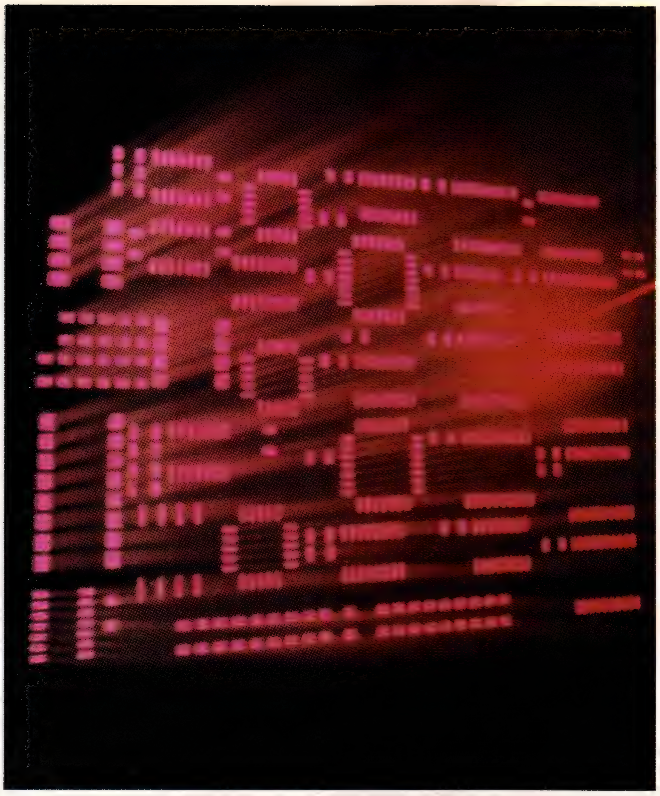
Bill Farrell, The Photo Works

Fig 1—Our fabricated pc board exhibits many of the attributes we were taught to incorporate in SMT board designs. Silk-screen component designators on the top of the board **(a)** mark and label the position of each component. We designed every pad pattern used. The bottom of the board **(b)** shows evidence of our manual editing. We put every diagonal trace on the board by hand because Cadnetix's automatic routers only generate vertical and horizontal traces. We believe the diagonal traces plus the manual redistribution we performed to even out the trace spacing enhanced the pc board's manufacturability.

black. Tektronix says its customers don't like this purely cosmetic defect. Although we didn't object to the board's appearance, we could have moved the vias another 20 or 30 mils away from the edge-connector fingers if we had known about this problem earlier.

We also erred by placing two bypass capacitors below the topmost excursion of the edge-connector fingers. This component placement forced Tektronix to take precautions that prevented those component pads from becoming gold plated. Gold plating poisons a surface-mount pad and destroys its solderability, just as a solder mask or silk-screen ink does. Had we known about this problem, we would have omitted the two offending bypass capacitors. Because these two problems were the only complaints Tektronix made about our board, we felt that all of our SMT training and preparation was starting to pay off.

Tektronix also commented that our pc board should be fabricated



This solder screen allowed a screen printer to deposit solder paste on our board's SMT pads but not on the pads for through-hole devices.

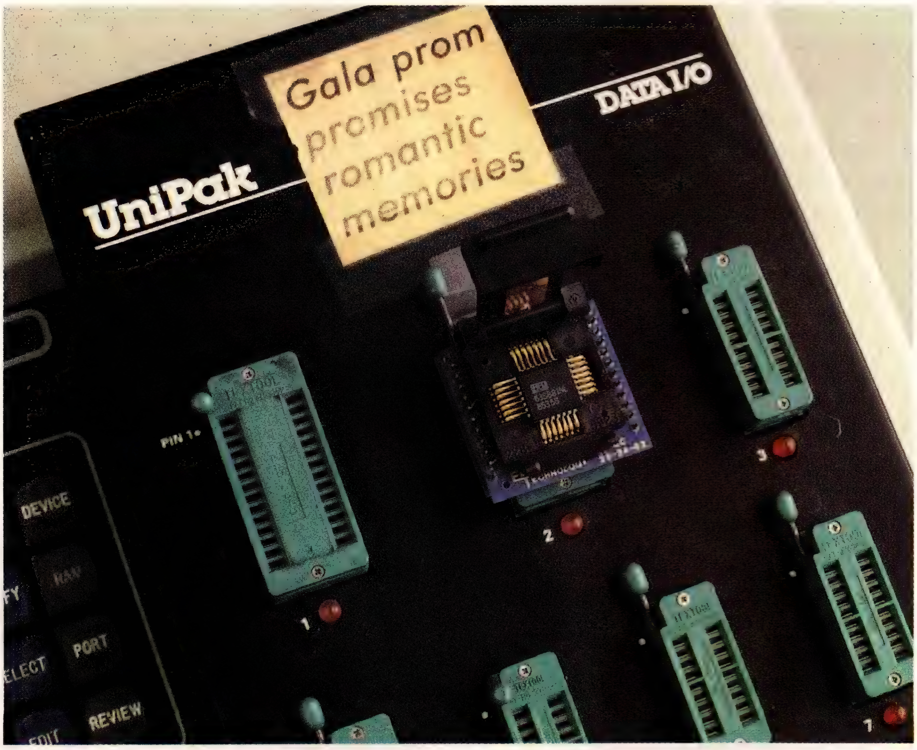
Bill Farrell, The Photo Works

with only one image per panel because of the small features and tight tolerances of our design. We left the panelization of the board up to the CAD operators at Tektronix, and they built our prototype boards with six images/panel. Apparently, the multiple-image panels created some problems when the manufacturing people tried to hold tolerances for all six boards on each panel through the fabrication process. However, the company overcame these problems because all of the pc boards worked as designed.

Now that we had the pc board and the parts, we were almost ready to assemble our project board. But before we could travel down to Texas Instruments' SMT Center for the assembly phase of the project, we had to program the PLDs and PROMs. AST provided printouts of the PLD equations and PROM listings, so once again we invited Murphy to join us on our project by typing this information by hand into our IBM PC's word processor. We double checked those transcriptions but still felt uneasy about manually transferring this information.

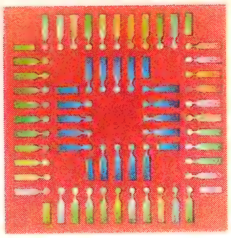
The Data I/O Model 29 we used at Cadnetix to program our devices accepts the ASCII-hexadecimal PROM files supplied by AST, but the equations for our PLDs had to be compiled into JEDEC-compatible download files before we could transfer them to the programmer. We compiled these equations using an IBM PC and Personal CAD Systems' CUPL compiler. Initially, we attempted to use an old version of CUPL that we'd had for a few years, but AST's PLD listings included statements that only later releases of the CUPL compiler could interpret. A frantic call to Personal CAD Systems netted us the necessary software, and the compilation proceeded without a hitch.

We drove over to Cadnetix with our PROMs, PLDs, the compiled files on a floppy disk, and our DIP-to-PLCC Adapt-A-Sockets from Emulation Technology. After the usual 15 minutes of fooling around with the RS-232C link between the Data I/O programmer and an IBM PC to get the two machines talking, we downloaded each file and burned our parts. Then we were ready for Texas Instruments.



The device programmer we used at Cadnetix did not have SMD sockets, so we used three Adapt-A-Socket adapters from Emulation Technology to convert the device programmer's DIP sockets to PLCC sockets.

Steven H Leibson



SMT, Texas style with all the fixin's

We arrived at Texas Instruments' SMT Center in Houston on November 3, 1986, a little more than a year after starting the SMT project. Dr Charles Hutchins, the SMT Center's manager, told us to allow three days to perform the assembly, but we allocated four days as a precaution. The job required only two days. One reason the work went quickly was that Jerry Pickert, an intern at the SMT Center, had made some preparations for our arrival. Using our parts list, he had bolted the appropriate parts carriers and feeders in place on the Quad Systems (Horsham, PA) Model 34 placement machine. (That machine is now called the Quad Start.) We loaded our parts onto the machine as soon as we arrived.

Because we were only assembling 10 boards, we didn't use hard tooling to hold the board in position on the placement machine. Instead, we used a carpenter's square for board alignment and fastened both the carpenter's square and our pc boards to the placement machine using transparent, double-sided adhesive tape. We put an additional layer of tape on the top surface of the board to hold components in position during training. (Don't laugh, the tape worked very well.) With everything in position, we started programming the machine with part locations.

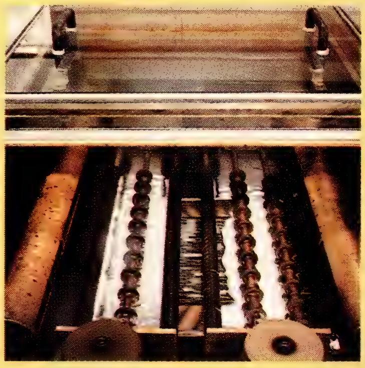
Every design engineer should experience programming a place-

Fabricating SMT pc boards

The Tektronix Printed Circuit Board Division (Tek PCB) became a merchant vendor of pc boards in April 1984. Previously, this division only supplied boards to other Tektronix divisions. We selected Tek PCB to fabricate our SMT project board for several reasons, including the company's familiarity with Cadnetix-format plot tapes.

Tek PCB offered us all of the pc-board manufacturing processes we wanted to use for our design. The 8-mil-trace with 8-mil-space design rules we used posed a simple problem for a company that can currently accommodate 2- or 3-mil conductors and 4- or 6-mil spaces. In addition, Tek PCB offered us SMOBC (solder mask over bare copper) and HAL (hot-air-leveled) solder fabrication processes. Both of these processes are ideal for SMT boards.

An SMOBC process applies solder mask to a pc board before plating. Solder mask generally adheres to bare copper better than it does to plated metal. The superior adhesion resists separation during reflow soldering and prevents solder on the surface-mount pads from draining off the pad by running down a trace conductor. Tek PCB applied a dry-film solder mask to our pc board using a double-burn photographic process that prevented the solder mask from encroaching on any of our SMD pads. If solder mask covers a pad, even partially, the solderability of that pad is destroyed. We had no soldering problems attributable to our pc boards.



The hot-air-leveled (HAL) soldering process Tektronix used to coat our fabricated pc boards with solder is ideal for SMT assembly. Air knives remove the excess solder and leave a uniform surface that encourages SMDs to stay put during reflow soldering.

After applying the solder mask, our boards were tinned in Tek PCB's HAL solder machine. During this process, a slurry of liquid solder covers bare-metal portions of a pc board, and air knives remove the excess molten metal. The HAL process produces an extremely flat surface on the pc board. We measured less than a 1-mil height difference between the tinned pads and the solder mask on our board. This smooth surface encourages the SMDs to sit flat on the board, reducing manufacturing defects from component tilt or movement during the reflow-soldering operation.

Although our design did not require them, Tek PCB can also fabricate a pc board that has blind or buried vias. Such vias do not bore completely through a pc board and are especially useful for SMT designs because they can leave one surface of the board relatively free of vias. That uncrowded surface can accommodate many more 1-layer SMD pads.

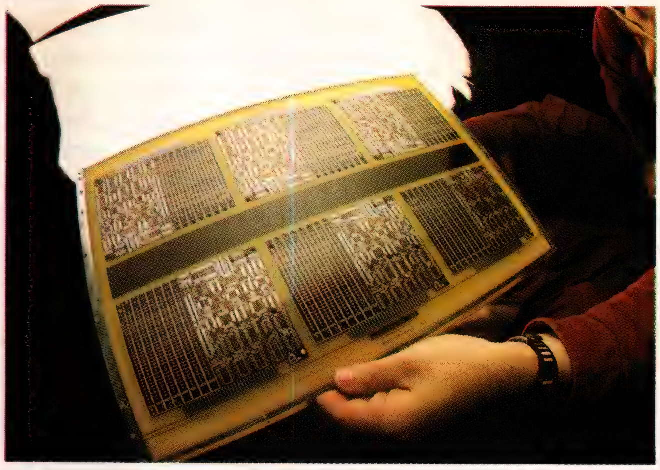
ment machine by hand at least once. It gives you a much greater appreciation for the people who do such tedious work regularly. You must program two positions for each part placed on the pc board. The first position tells the placement machine where to obtain a part from a feeder or part carrier, and the other position describes where the machine is to place the part. Each site is located in a 5-dimensional space: X, Y, Z, rotation, and placement-head number. The placement-head number specifies which of four vacuum chucks the machine should use to pick up the SMD.

Our board contains more than 100 SMDs, and we had to show the placement machine where to pick up and where to put each one. Of course, if the placement machine could have used the component location information directly from our CAD tapes, we would have avoided this training. But once again we stepped in and effected the transfer of information between one computer-based tool and the next by hand.

Ergonomics 101 for assembly tools

The nonergonomic design of the placement machine's control panel complicated our task. The control panel is a small, handheld box about the size of a portable DMM, and it's attached to the placement machine by a coiled cord. You move the machine's placement head using buttons (which resemble a computer keyboard's cursor keys) on the control panel's nontactile, membrane keyboard. We found the arrangement of the placement-head control buttons to be nonintuitive, and we often started the placement head moving in the wrong direction by pressing the wrong button. We would have preferred to use a joystick control for this operation.

You need many sample parts to program the placement machine, and we experienced component shortages because we lost several SMDs during the training session. Passive SMDs frequently jumped out of the vibratory feeders and irretrievably dropped into mounting holes on the placement machine's work surface. (The SMT lab provided dummy ICs—with no silicon inside—for training the machine, but we dipped into our project stock for passive SMDs.) Later, during assembly, we ran out of chip resistors on the last pc board. Next time we'd prefer to have a much larger supply of components available for training purposes.



Although our prototype boards were fabricated six to a panel, Tektronix believes it would achieve optimal manufacturing yields by fabricating only one board per panel.

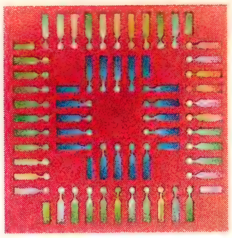
Bill Farrell, The Photo Works

Steven H Leibson

A carpenter's square served as the only tooling we needed for pc-board alignment on the placement machine. We covered both sides of the board with transparent, double-sided adhesive tape while training the machine to place components. The tape on the bottom surface held the board in position on the machine, and the tape on the top surface held the components in place during training.

A long way to see a small thing

Another problem we encountered during placement-machine training was caused by the minute size of SMDs. The layout of the placement machine forced us to stand about two feet from the pc board as we tried to align the components with 0.001-in. accuracy. The placement head often obscured our view, forcing us to drop the component on the board, move the placement head away from the component, and then check our positioning accuracy. We repeated this process for



every component on our board. (Now, you can attach video cameras to the placement head on many placement machines for a bird's-eye view of the placement site. Our experience with the placement machine gives us a great appreciation for this feature.)

By early evening on the first day, we had completed the machine's training for all of the passive-component sites and for the locations of some ICs. Mr Pickert spent another two hours that evening to complete the training for the remaining ICs. We were ready to start assembling boards early the next morning.

As a first step in assembling the boards, we set up the screen printer. Dr Hutchins had the solder screen made for us at Microcircuit Engineering Corp, the vendor he normally uses for TI's SMT boards. The solder screen slipped into a deHaart (Burlington, MA) screen printer. We used double-sided adhesive tape again, this time to hold our pc board in place on the screen printer's platen. Next, we had to align the solder screen with the pc board. That process turned out to be more difficult than it appeared, because the adjustment controls on the screen printer allow three degrees of freedom: X, Y, and θ. Lack of solder-screen targets on our pc board also complicated this task.

Some SMDs needed the human touch

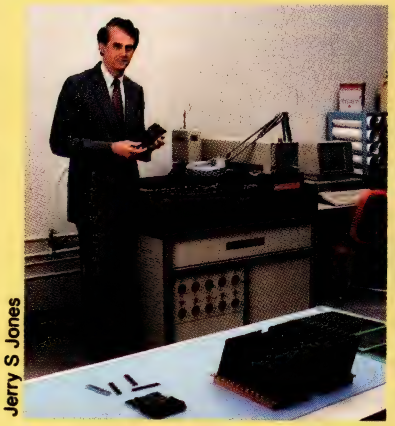
We finally lined up the solder screen with a sample pc board and then screen-printed solder paste on all 10 boards. That part of the job took very little time. Then we carried each screened board to the placement machine for the 5-minute operation that put most of the SMDs onto the board. We hand-placed the surface-mount switches and the pin header because the SMT Center didn't have component carriers for those devices. We also added one of the PLCCs to each board by hand because they didn't fit into the component carriers. Apparently, the leads on these particular PLCCs were formed just a

SMT at Texas Instruments

As a vendor and user of SMT ICs, Texas Instruments has a strong interest in furthering surface-mount technology. To that end, the company created a lab called the TI SMT Center to help customers learn about SMT. We assembled the EDN project board at TI's SMT Center. Dr Charles Hutchins heads that lab and manages the company's SIP module assembly facility as well. Because SIPs incorporate SMDs, the lab and assembly line complement each other quite well. The arrangement also worked well for us because each EDN project board incorporates eight 256k×9-bit SIP memory modules.

The SMT Center contains all of the equipment needed to build SMT boards, including screen printers, placement equipment and component feeders for the placement machines, IR and vapor-phase soldering machines, and inspection equipment. The SIP assembly line uses the IR reflow-soldering machine on a regular basis. TI customers can arrange to visit the SMT Center for training through their local TI field sales engineer or distributor.

TI recently expanded the scope of its SIP assembly facility by branching out into a product it has dubbed memory-intensive modules (MIMs). These products incorporate surface-mounted memory devices like SIPs and contain additional devices like address decoders and memory-array drivers to create an entire memory subsystem on a plug-in card. TI builds MIMs for each customer by contract. You can design the module, or the company will develop a design to your specifications.


Jerry S Jones

Dr Charles Hutchins manages Texas Instruments' SMT Center and the SIP-module assembly line in Houston. Next to Dr Hutchins is the Quad Systems Model 34 placement machine we used to assemble our project board.

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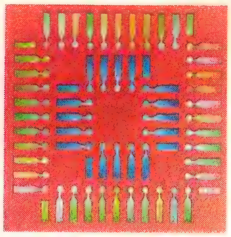

little larger than normal. The time required to put all of the components on each pc board totaled about six minutes per board.

We planned to run five of the boards through TI's IR reflow-soldering furnace and the remaining five boards through its vapor-phase reflow-soldering unit. However, the SIP manufacturing line was using the IR furnace. Every SMT board requires a different heat profile for the IR soldering operation, so in order to use the IR furnace we would have had to stop the SIP production, change the temperature profile on the furnace, solder our boards, and then reset the profile for the SIP modules. The SIP production people probably wouldn't have appreciated our interruption, so we elected to solder all of the boards using the vapor-phase process.

Inside a vapor-phase, reflow-soldering tank, heaters vaporize an inert, fluorocarbon fluid. As the cold pc board with its load of solder paste and SMDs drops into the tank, it causes some of the fluorocarbon vapor to condense. The vapor releases its heat of vaporization as it condenses and melts the solder paste to form soldered joints.

In less than 10 minutes, we had dunked all 10 boards into the reflow bath, soldering all of the SMDs. After reflow soldering, only the through-hole SIMM sockets remained to be added to our pc boards. We hand-placed eight sockets on each board and ran the boards through a hand-operated wave-soldering machine TI uses to add connectors to a memory board it builds. Because we used this hand-soldering machine with its small solder wave, the only portion of our board exposed to the molten solder was beneath the SIMM sockets. Thus, all of the vias in the control-circuit portion of the board remained open.

For more information . . .

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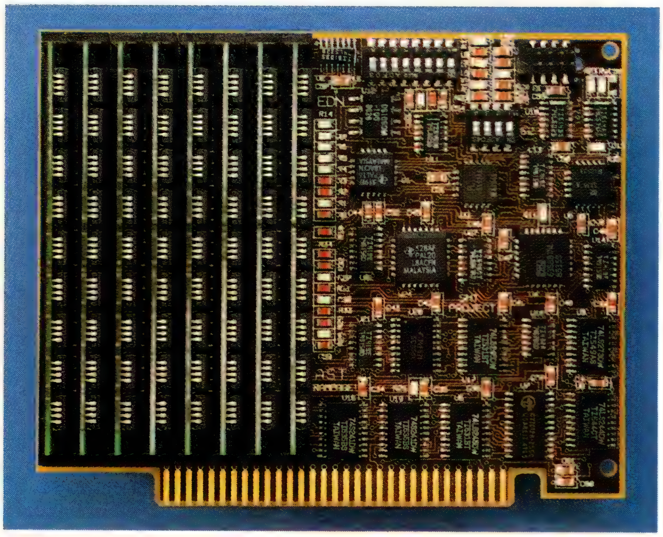

Bill Farrell, The Photo Works

With all the components mounted, the finished EDN project board acquires a gem-like appearance because of the small device geometries.

Plug those vias

We should have plugged the vias to allow the vacuum hold-down on Hewlett-Packard's pc-board ATE to operate properly. To accomplish the plugging, we should have masked the edge-connector fingers and run the entire board over a solder wave. The fiberglass pc board would have acted as an insulator, preventing the reflowed solder from melting and consequently keeping the SMDs in place during the wave-soldering operation.

We left the vias open unintentionally. In fact, we specifically designed the board to allow solder to enter all of the vias during wave soldering by excluding vias from beneath our passive SMDs. We simply didn't think of the con-

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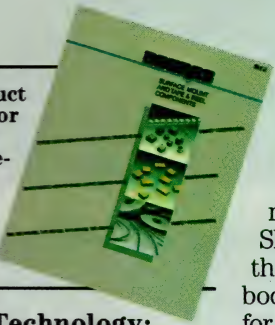

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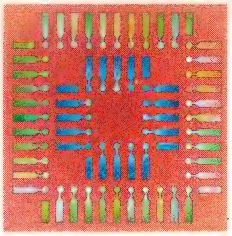

sequences of leaving the vias open when we assembled our boards.

Because we left the vias open, HP had to add a movable lid with mechanical probes that forced the board down onto the tester's bed of nails. The lid increased the test time per board because an operator had to open and close it for each test. The lid also complicated testing because it prevented an operator from flipping the surface-mount switches on our pc board during the test. As a result, we decided to forego testing of those switches on the ATE.

In the final assembly step, we snapped SIP memory modules into all of the SIMM sockets. Then, with our boards completely assembled, we boarded a plane and returned home. We subjected the boards to close visual inspection and found multiple manufacturing defects on eight of the 10 boards (**Fig 2**). The most common defect was tombstoning of chip resistors, a condition in which one end of a resistor is pulled up off the board, creating an open circuit. We believe the major reason for the tombstoning was improper placement of the devices caused by the use of a chuck designed for 1210 SMDs instead of the 1206 devices we used. (The SMT Center didn't have a 1206 chuck.)

The oversized chuck allowed the devices to move during placement on the board so that both ends of the device were not well inserted into the solder paste. When the solder paste melted during reflow, one end of the resistor experienced more force from the solder's surface tension than the other end did. That differential surface tension caused one end of the device to lift from its pad. None of the chip capacitors tombstoned. We attribute that situation to the extra mass of the capacitor overcoming the ef-

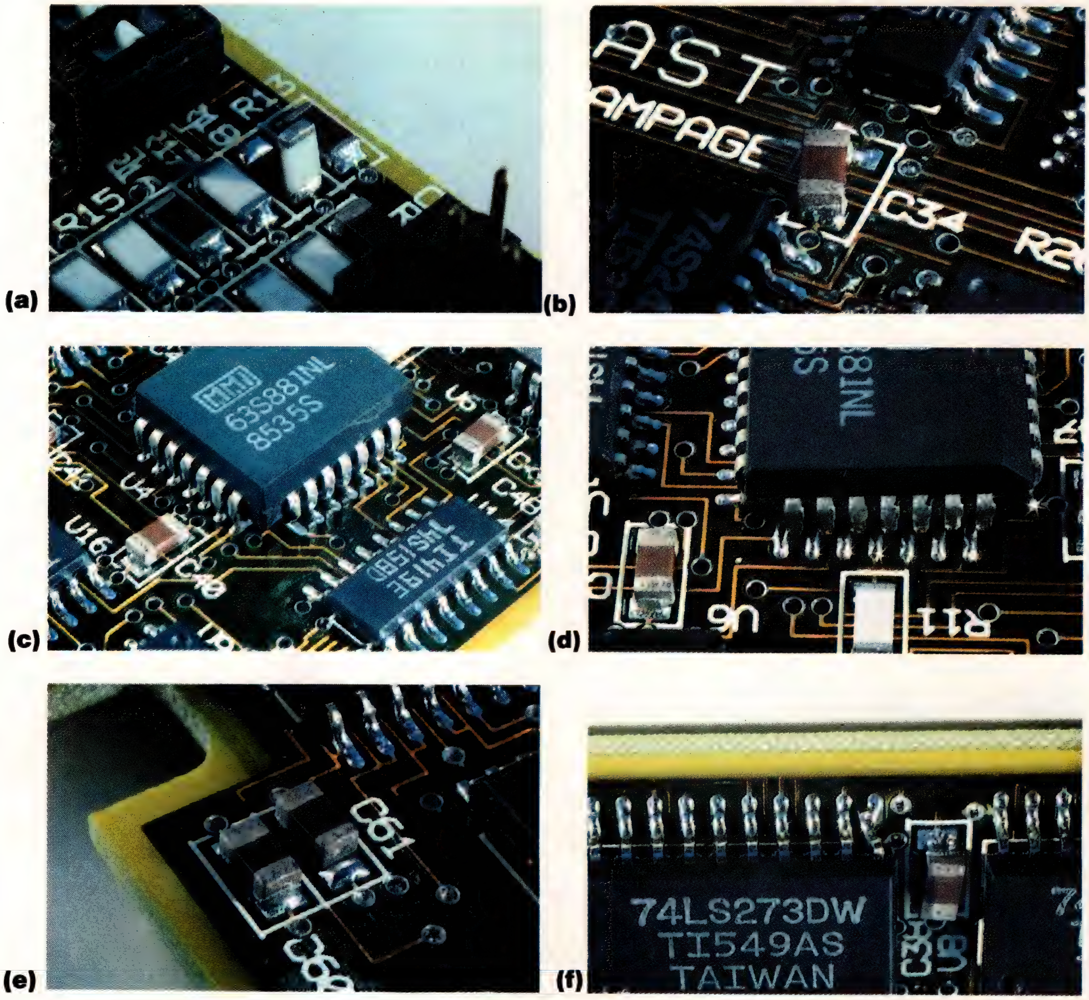

Fig 2—Our boards contained a rogues' gallery of manufacturing defects, including tombstoning **(a)**, drawbridging **(b)**, open circuits caused by noncoplanar leads **(c)**, and poorly placed SMDs **(d** and **e)**. We also spotted a bent SOIC lead **(f)** that did not cause a problem in this instance but that could have resulted in either an open or short circuit.

Bill Farrell, The Photo Works

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Kazuhiko Kobayashi, manager of the Systems Engineering Division of Hitachi Ltd. "Factory automation in the Japanese computer industry"

Hiroshi Komiya, head of the Saijou Works, Mitsubishi Electric Corp. "Manufacturing technology in the semiconductor industry"

Bill Totten, president of Ashisuto K.K. "The Japanese market for U.S. and European software"

David H. Johnson, senior manager for Network Systems Sales, AT&T International. "Opportunities for U.S. communications manufacturers in Japan"

Dinker Bir, vice president of technology at Northern Telecom Japan Inc. "Trends in telecommunications"

Pat O'Malley, strategic marketing director for the Semiconductor Sector at Nippon Motorola Ltd. "The Japanese semiconductor market"

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fects of surface tension. Our chip capacitors are much heavier than our chip resistors, even though both are 1206-size devices, because the capacitors are much thicker.

We also discovered a few open circuits on some of the PLCC leads that probably were caused by a lack of lead planarity. Remember, all of our PLCCs are programmable devices, and we had subjected them to a lot of handling. We selected PLCCs over SOICs for our programmable devices to avoid lead deformation during handling, but we apparently did not avoid that problem completely.

Two of the boards looked perfect to the unaided eye, so we ripped the lid off our IBM PC, removed the AST Rampage! from its slot, set the switches on our SMT Rampage!, and plugged the short card into the computer. A little apprehensive, we flipped on the power to the computer and waited. In less than 30 seconds, a parity-error message appeared on the computer's display and mocked us. The same event occurred for the other "good" board. Our SMT boards didn't work. That put the ball in HP's court. We needed the ATE board tester to tell us what went wrong.

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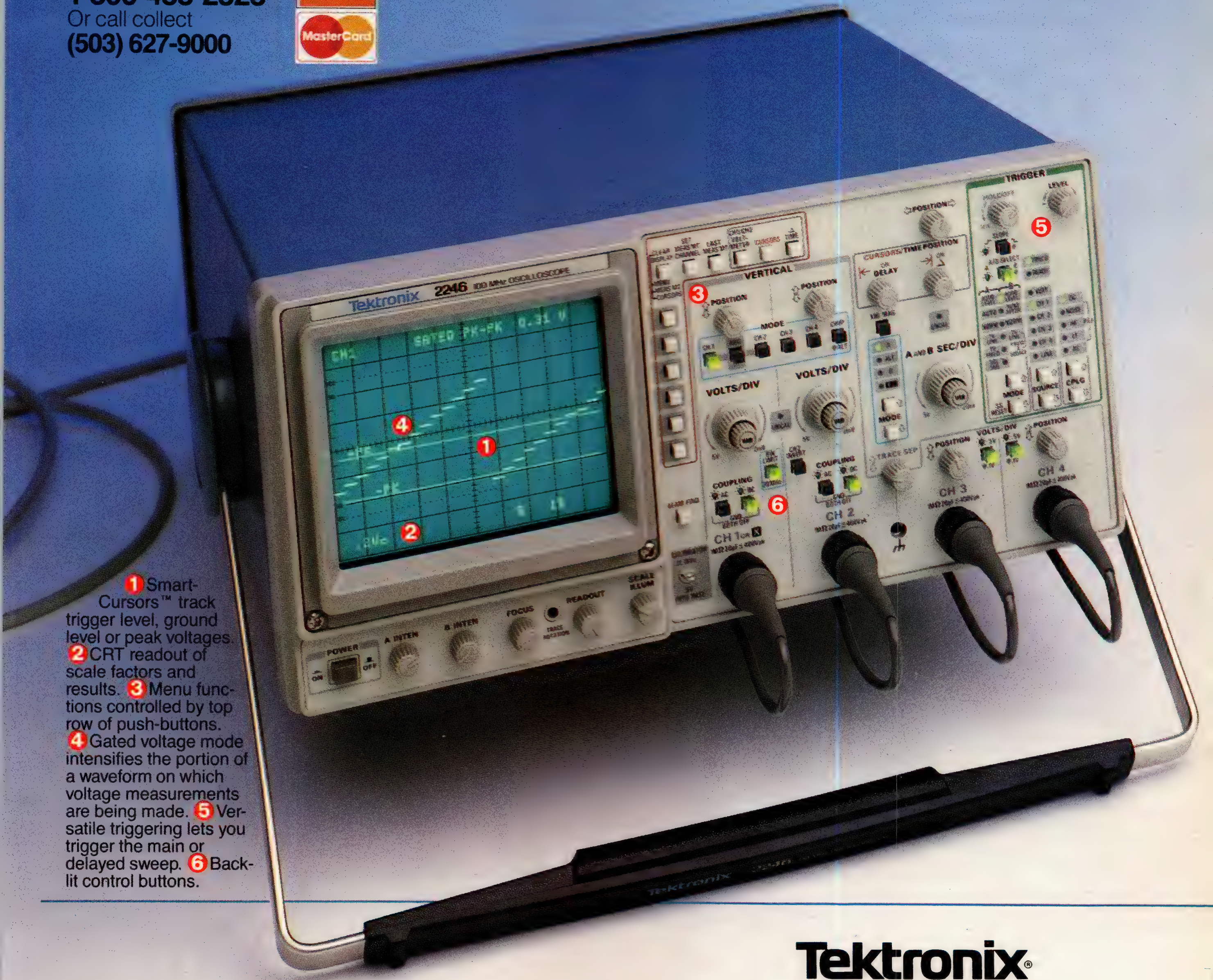

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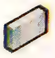

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TC TO ± 25 ppm/°C

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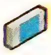
1 Ω TO 10M Ω, TOL. TO ± .5%,
1/4 TO 2 W

SEMI-PRECISION WIREWOUND
.1 Ω TO 1.5K Ω, TOL. TO ± 0.25%,
3 W



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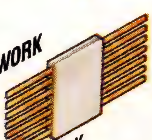

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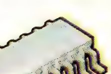

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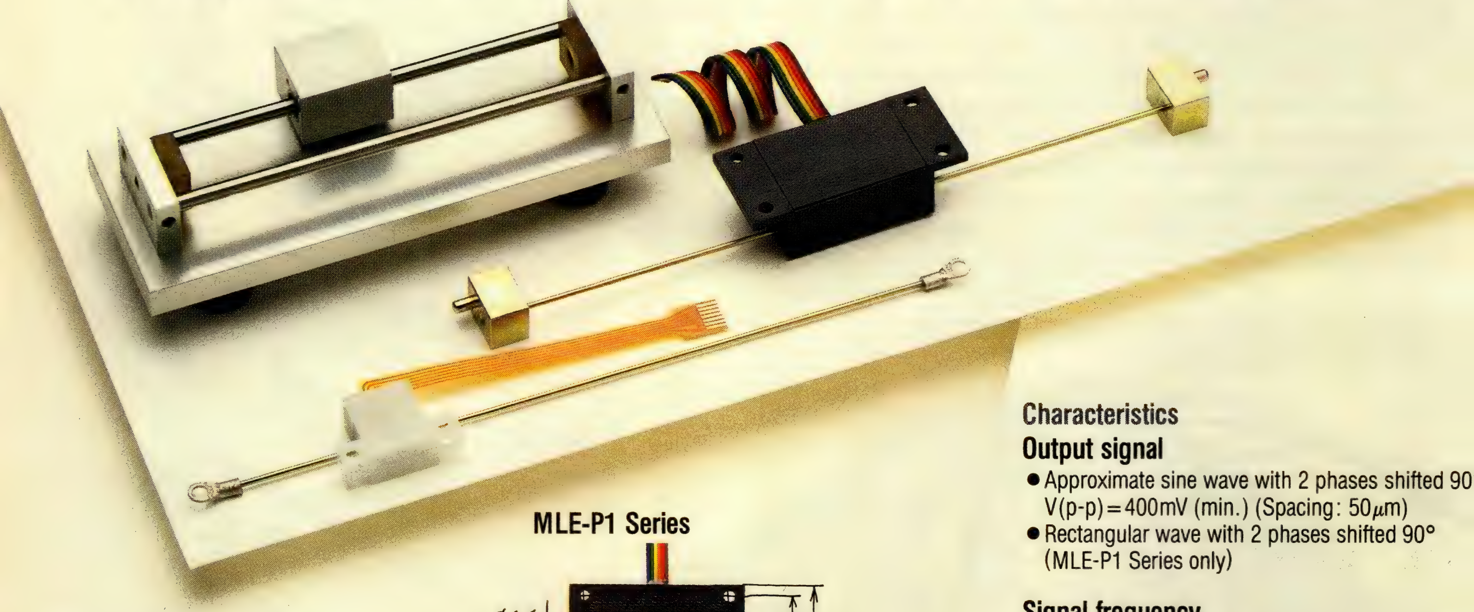

Shapes and Dimensions

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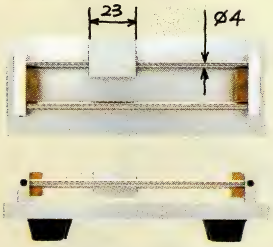

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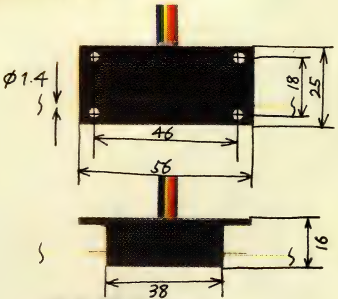

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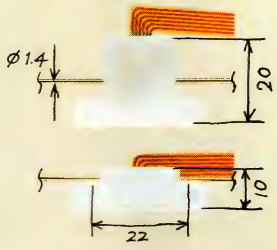

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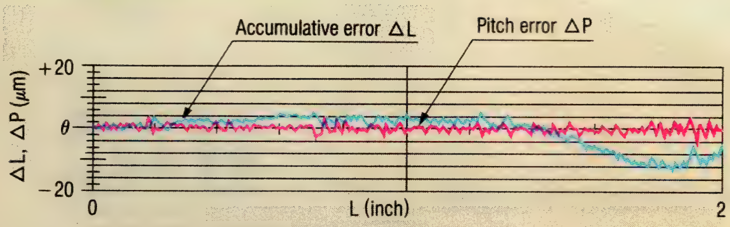

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Pitch error = pitch (detected by the Tokin linear encoder) − set pitch

Characteristics

Output signal

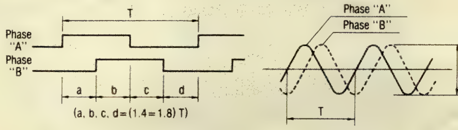
- Approximate sine wave with 2 phases shifted 90
  V(p-p) = 400mV (min.) (Spacing: 50μm)
- Rectangular wave with 2 phases shifted 90°
  (MLE-P1 Series only)

Signal frequency

1) T = 1/120 inches (211.7 ± 10μm)
2) T = 1/90 inches (282.2 ± 10μm)
3) T = 1/60 inches (423.3 ± 10μm)

Waveform

- Rectangular wave
- Approximate sine w



(a, b, c, d = (1.4 = 1.8) T)

Specifications

	MLE-P1 Series	MLE-P2 Series	MLE-D Seri
Cumulative error	50μm or less/200mm		
Magnetic scale diameter	ϕ1.4		ϕ3.0 or ϕ4
Magnetic scale length	800mm (max.)		120mm (ma
Response frequency	50kHz (min.)	200kHz (min.)	
Power supply	+5V DC ±10%		

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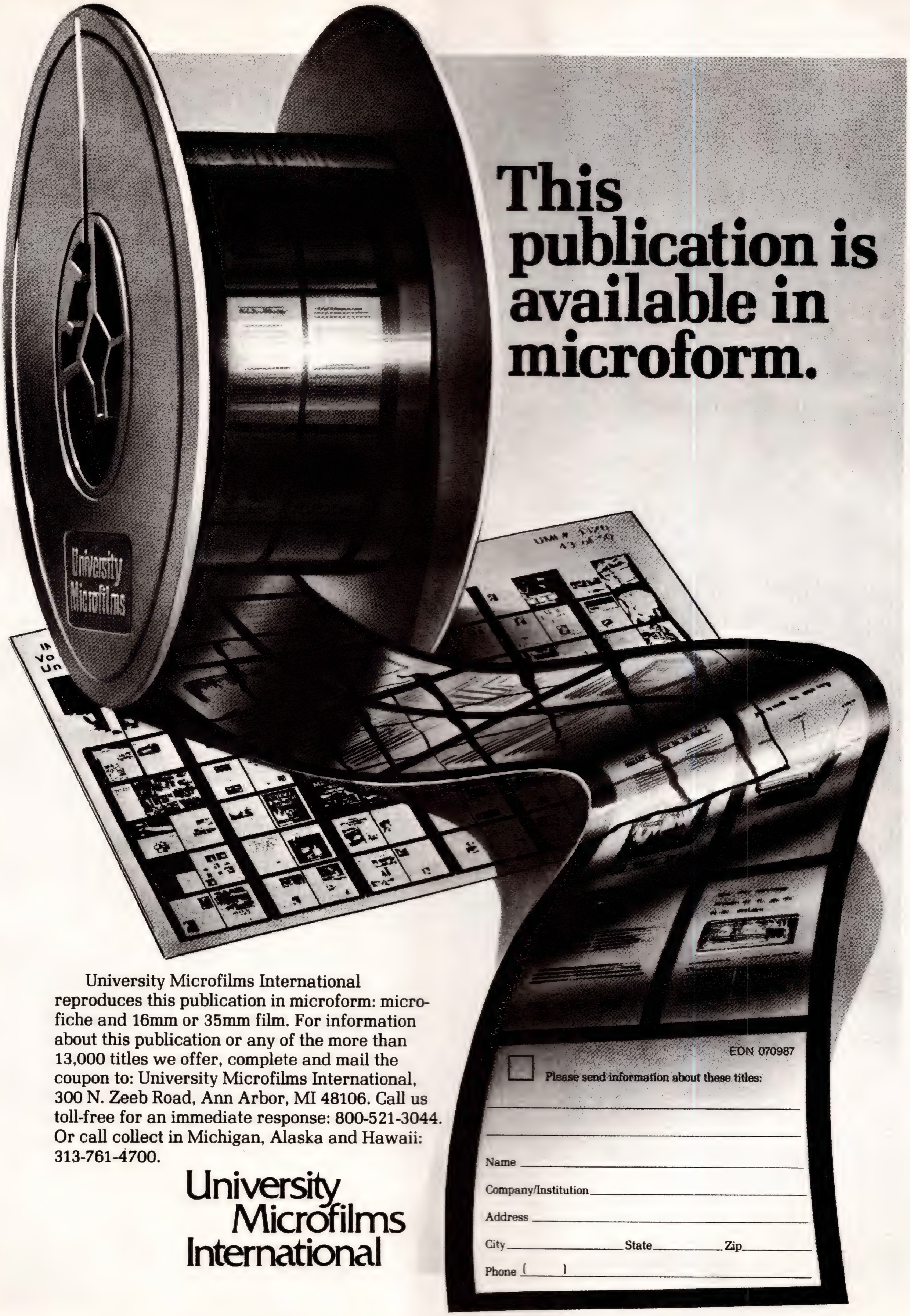

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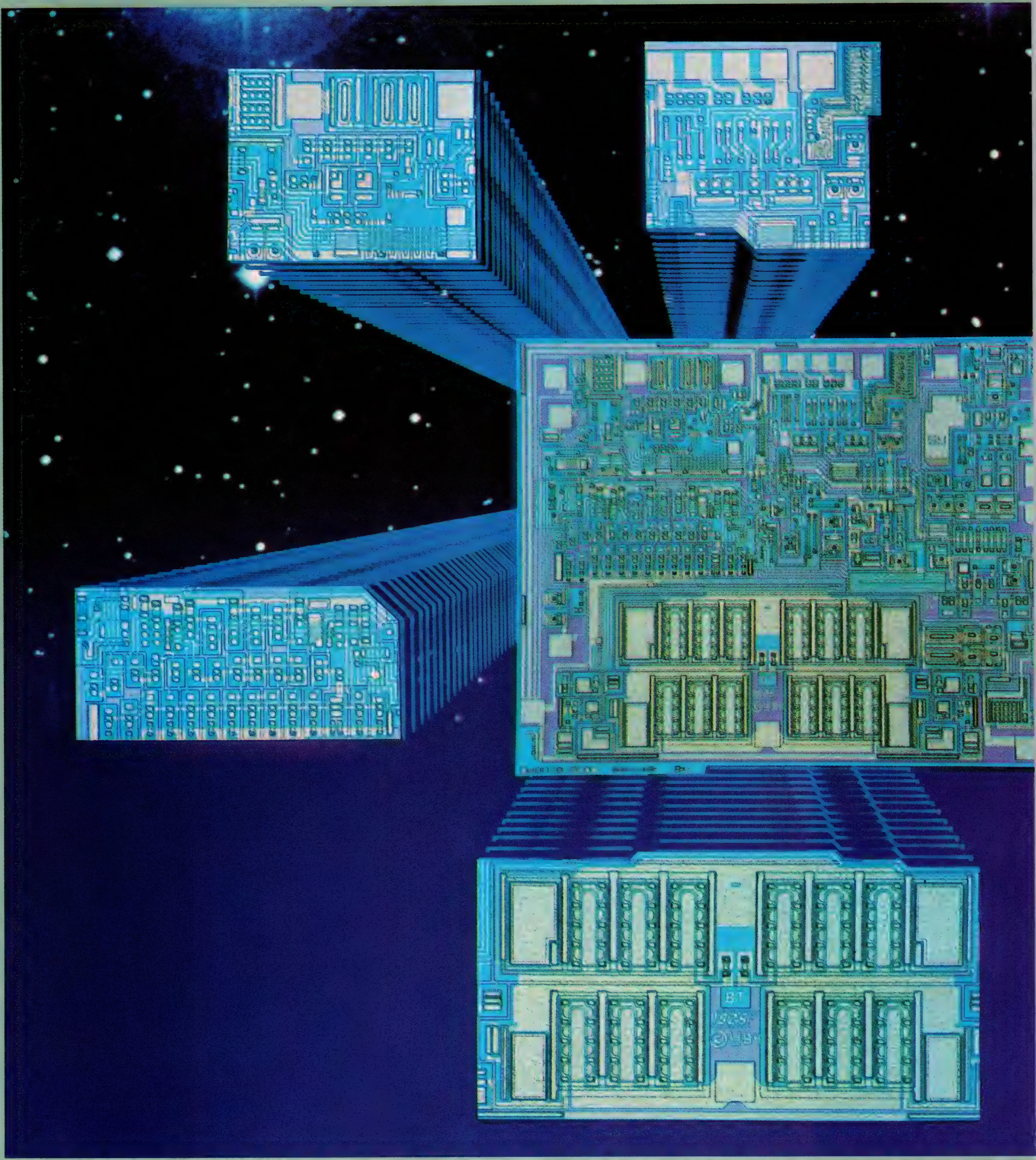
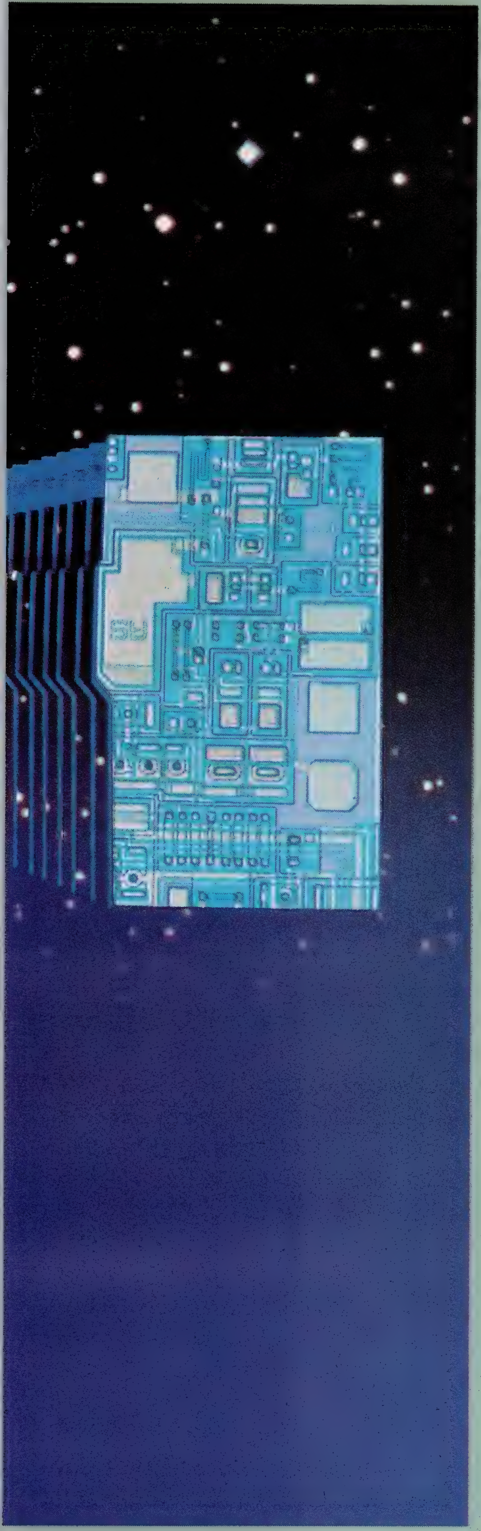


Integrated Circuits



Dual-mode 1-MHz switching regulator
(Unitrode Corp)

Switch-mode power-supply ICs extend performance boundaries

A new generation of switching-control circuits is changing the way designers address switch-mode power-supply regulation. Devices for implementing voltage-mode, current-mode, and resonant-mode control can improve performance, operate at higher frequencies, and simplify control circuitry.

Dave Pryce, *Associate Editor*

In the early days of switch-mode power-supply design, regulator circuits consisted of op amps, comparators, logic blocks, and discrete diodes and transistors, and the circuits suffered from the disadvantages of high component count, large-sized pc boards, and high cost. As the demand for switching power supplies increased, manufacturers of integrated circuits began to offer monolithic control circuits specifically designed to provide the required regulation without incurring cost and size penalties.

Voltage-mode control is alive and well

Among the first such voltage-mode devices were the SG1524 and SG1525 Series from Silicon General and the TDA1060 from NV Philips (later to become the NE5560 from Signetics). These types, along with several other first- or second-generation circuits, are now offered in upgraded "A" and "B" versions and remain popular, particularly in existing designs where retrofit is important. Many of them, however, have lost favor to other voltage-mode-control types that offer not only tighter regulation but also better housekeeping features, simpler external circuitry, or greater application utility.

Even the method of control is changing. Many of the newer devices incorporate current-mode control instead of the heretofore universally accepted voltage-mode control. A third method of control, resonant-mode, also has its advocates, and devices utilizing this method of control are now becoming available. Moreover, some also offer more than one type of control **(Table 1)**.

Voltage-mode control ICs employ pulse-width modulation for regulating the output voltage in switch-mode power supplies. PWM provides effective control over a wide range of power supply loads, except at the lower end where a limitation is imposed because of minimum pulse-width requirements. To overcome this limitation, the CA1523 controller from RCA Solid State Div combines pulse-interval modulation (PIM) and PWM to regulate the power-supply output voltage.

PIM can better handle low loads because the duty cycle is reduced by

TABLE 1—SWITCHING-REGULATOR ICs

MANUFACTURER	MODEL	CURRENT-MODE	VOLTAGE- MODE	RESONANT-MODE	2-CHIP SET	PRICE (1000)
CHERRY SEMICONDUCTOR	CS-320	●				$2.87
INTERSIL	ICL7675 ICL7676		●		●	$2.64 (SET)
INTEGRATED POWER	IP3P00 IP3P01		●		●	$1.80 (SET)
LINEAR TECHNOLOGY CORP	LT1070	●				$6.90
LINEAR TECHNOLOGY INC	LD405			●		$3.50
MOTOROLA	MC34129	●				$0.96
RCA SOLID STATE	CA1523		●			$0.96
SILICON GENERAL	SG3528	●	●			$2.20
UNITRODE	UC3825	●	●			$3.83

increasing the pulse interval, rather than by reducing the pulse width. The CA1523 doesn't rely on PIM alone, however, because the lower operating frequency resulting from the increase in pulse interval can cause filtering problems. (For further information on this part, see "Variable-pulse modulator improves power-supply regulation," EDN, June 25, 1987, pg 251.)

A common predicament for designers is how to satisfy the isolation requirements of such regulatory bodies as UL, VDE, and CSA in off-line switch-mode power supplies while maintaining the desired regulation. In a typical application, the RCA part solves this problem by using the simplest method of primary-to-secondary isolation. By means of an auxiliary winding on the switching transformer, the circuit supplies pseudo output-voltage information to the input of the error amplifier in the control IC. This auxiliary winding supplies power to the IC following the start-up from a resistor connected to the unregulated dc-supply line. The principal disadvantage of this method is the relatively poor regulation—typically 5 to 10%.

A second, often-used method of providing isolation uses an ac line transformer to provide the low supply voltage required by the PWM control circuit. This IC, located on the secondary side, drives the switching transistor in the primary side via a pulse transformer. Including the switching transformer, this method requires a total of three transformers. Besides adding bulk and weight, it isn't very cost-effective—although it does provide good regulation.

Another popular method of providing isolation uses an optocoupler. This method has the advantage of providing secondary control of the output voltage, although it doesn't provide a perfectly isolated coupling system because of thermal effects and the leakage characteristics of the optocoupler. It also makes certain circuits in the PWM control IC superfluous unless the IC specifically favors this type of application. The added circuit complexity also increases the cost of the system.

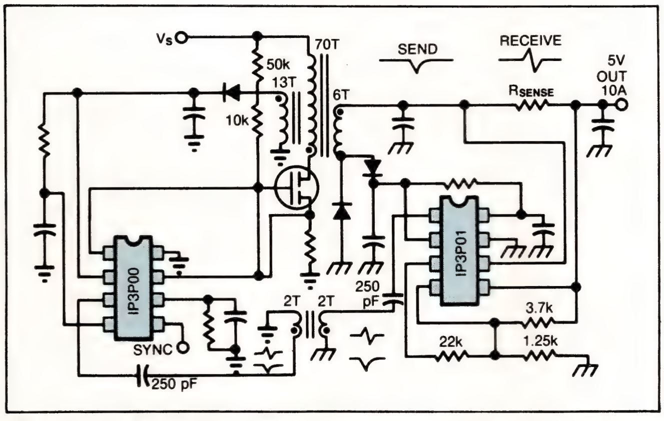


***Fig 1—This flyback-type power supply** uses the IP3P00/IP3P01 chip set from Integrated Power Semiconductors to overcome the isolation-barrier problem. The circuit includes an MOS switch, primary overcurrent protection, secondary current-limiting capabilities, and a soft-start function.*

In contrast with these three approaches, Integrated Power Semiconductors solves the isolation problem with a 2-chip set of voltage-mode-control ICs—the IP3P00 (primary) and IP3P01 (secondary). Each circuit controls its own specific tasks. In general, the secondary-side chip controls the analog functions, and the primary-side chip controls the digital functions. The transformer-type communication link between the primary and secondary circuits is integral to the design concept. It provides low-energy bidirectional coupling that is both electrically and mechanically simple. In its simplest form, the transformer can be a 1- or 2- turn primary and secondary wound on a toroid.

Fig 1 is a simplified schematic for an off-line flyback converter with an MOS switch, primary overcurrent protection, secondary current limiting, and a soft-start function. The circuit operates at a typical frequency of 200 kHz. A bridge rectifier connected to the ac line normally provides the circuit supply voltage, V_S. Coupling capacitors inserted in series with the windings of the feedback transformer block the flow of direct current.

Intersil also offers a 2-chip set: The ICL7675 and ICL7676 provide the necessary control circuitry for regulation of a single-ended, transformer-coupled, flyback-type switching supply. The chip set only operates in this type of configuration, and internal trimming provides a regulated 5V output with a typical tolerance of 2% and a maximum tolerance of 5% under all conditions. Output duty cycle varies from 5 to 75%. Supply current at no load is less than 3 mA for both chips over the full temperature range.

Power-supply designers have an ever widening array of regulator circuits from which to choose—including complete systems on a chip.

Fig 2 shows a typical system application. The output of the ICL7675 primary-side controller drives the power-MOSFET switch in the transformer primary. The switch turns off at a time corresponding to the falling edge of the internal system clock at a frequency of 50 kHz. After the initial soft-start cycle, the switch turns on at a time corresponding to a pulse received from the ICL7676 secondary-side controller via a pulse transformer. The secondary-side controller detects the power switch turn-off at the secondary of the transformer and initiates a time-out sequence whose duration is directly proportional to the output voltage. A pulse that occurs at the end of the time-out period feeds back through the pulse transformer to the primary-side controller, thereby completing the control loop.

The high-voltage dc output of the bridge rectifier supplies power to the primary-side controller via a resistor that feeds current to the on-chip zener diode, thus eliminating the need for a separate power supply. A resistor in series with the source terminal of the power MOSFET detects excessive current, forcing the primary-side controller into the soft-start mode.

Current-mode control leads the pack

Although voltage-mode control remains viable for regulating switching power supplies, current-mode control is becoming increasingly popular: Among its features are inherent pulse-by-pulse current limiting, direct control of the inductor current with minimum phase lag, easily applied output-current feed-forward to obtain fast correction of load transients, and the ability to parallel output power stages with equal current-sharing. Some chips are capable of either current-mode or voltage-mode control, providing more flexibility.

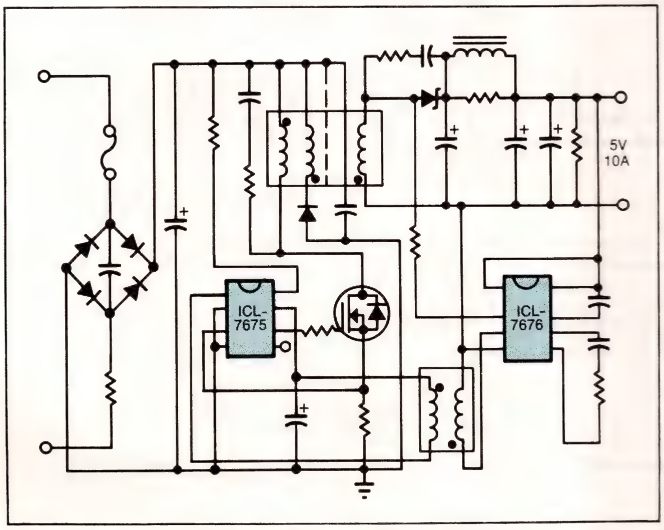


Fig 2—The ICL7675/ICL7676 2-chip set *from Intersil operates only in a single-ended, transformer-coupled flyback-mode. It provides a regulated 5V output with a typical tolerance of 2%.*

Most current-mode control chips have been of the fixed-frequency type, turning on the power switch in response to a built-in clock signal. The Unitrode UC1842 and UC1846 Series, along with equivalent types from other suppliers, are representative of this type.

The CS-320/CS-321 from Cherry Semiconductor, however, provides three methods of current-mode control: hysteresis, constant off-time, and fixed frequency with turn-on at clock time. Each of these methods senses the peak inductor current in a switching power supply; the hysteretic method senses both the peak current and the valley current. (For a more detailed description, see"Switching-regulator IC offers three methods of current-mode control," EDN, June 25, 1987, pg 114 .)

The CS-320 has an output stage that is active high; the CS-321 is active low. Either IC is capable of operating at frequencies as high as 1 MHz. The high-current totem-pole output stages have rise and fall times of 30 nsec (typ), allowing you to drive power MOSFETs. A high-gain current-sense amplifier lets you interface with the newer MOSFETs that have a few of the internal cells of the device brought out to an external pin.

Chip overcomes high-frequency limitations

Many of the switching power supplies on the market still operate at frequencies under 100 kHz, but there is a definite trend to higher frequencies. The UC1825 Series, a current-mode control IC from Unitrode, is specifically designed to overcome the high-frequency limitations inherent in most control ICs; it operates at 1-MHz switching frequencies and higher. In fact, Unitrode has a demonstration kit using the UC3825 in a 50W push-pull dc/dc converter that operates at 1.5 MHz. Accompanying the kit is a 20-pg manual that takes you step-by-step through the component-selection and design process.

You can configure the UC1825 chip for voltage-mode operation as well, and you can use it in a number of applications, including off-line, bridge, and flyback configurations. The chip contains an oscillator, undervoltage-lockout circuit, trimmed bandgap voltage reference, wideband error amplifier, PWM comparator

New techniques for voltage-mode control provide both pulse-width and pulse-interval modulation.

and latch, toggle flip-flop, soft-start section, and comparators for overcurrent sensing (**Fig 3**). The input to the PWM comparator goes to a separate pin so that you can connect it to either the timing capacitor for conventional designs or to a current-sensing network for current-mode control schemes.

In normal operation, the oscillator runs at a fixed clock frequency and issues blanking pulses to terminate one period and begin the next. These pulses reset the PWM comparator while blanking the outputs off. Following the blanking pulse, one output turns on until the ramp input exceeds the error-amplifier output voltage. This sets the PWM latch, which turns the output off and triggers the toggle flip-flop, selecting the other output for the next period.

The functions in **Fig 3** that set the 3825 apart from other circuits in terms of high-frequency capability are those indicated by darker lines. These speed-critical paths are the PWM comparator, the current-limiting comparator, the PWM latch and associated logic, and the output stage. Propagation delay is of paramount importance. In the 3825, the delay from either the ramp input or the current-limit sense-input to the output pins is typically 50 nsec. The speed-critical paths use a form of ECL and emitter-follower buffers to achieve the necessary speed. Complementing this fast logic are dual totem-pole output stages capable of driving a 1000-pF load rail-to-rail in 30 nsec at a peak current to 1.5A.

(In addition to this dual-output chip, Unitrode also sells the UC3823, which offers the same high-frequency performance for single-ended forward or flyback converters.)

Silicon General, a pioneer in the development of

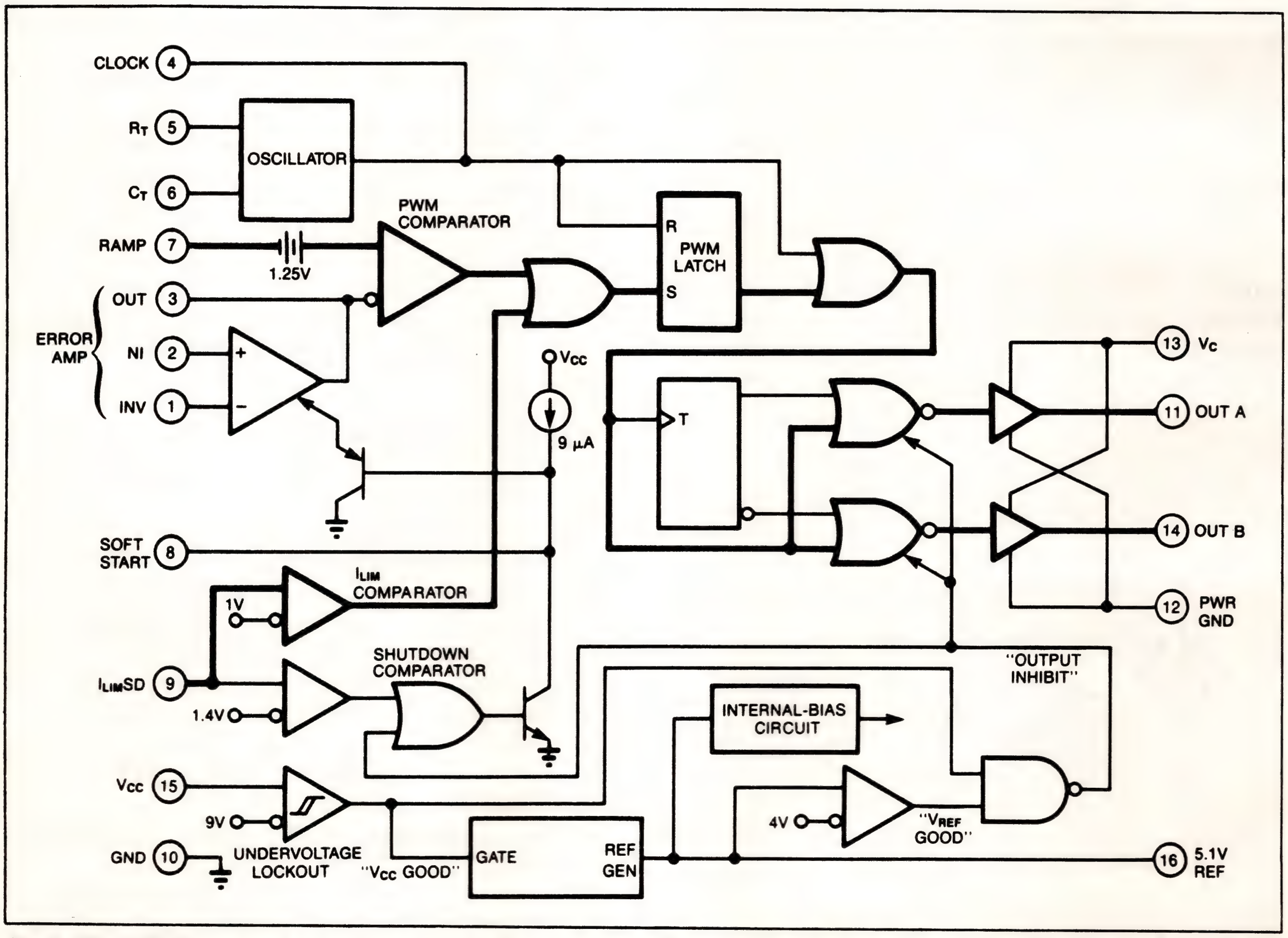


Fig 3—The UC3825 is suited to either current-mode or voltage-mode control. *The chip, from Unitrode, is specifically designed for high-frequency operation: The darker lines indicate the speed-critical paths requiring special attention during the design process.*

PWM control circuits, offers the SG1528, a device that you can use to provide all the control requirements for a single-ended, off-line switching power supply. **Fig 4** shows the SG1528 connected as a forward converter employing current-mode control. As an option, you can connect the IC to operate as a voltage-mode controller.

In **Fig 4,** the low-power start-up section ensures that the IC consumes a minimum amount of current (<1 mA) until the V_{IN} supply voltage reaches 16.5 to 18V. Thanks to this section, a high percentage of the current in the bleeder resistor from the high-voltage bus charges the start capacitor rather than supplying the PWM chip. As the start-capacitor voltage ramps up from 0V, internal circuitry generates low, controlled currents that prevent the reference regulator from turning on; hold the soft-start capacitor in a discharged state; and force the output driver into the low state.

When the supply voltage reaches the turn-on value of 16.5 to 18V, the reference regulator turns on, providing operating bias to the rest of the circuit. The output driver then turns on, and the release of the soft-start capacitor allows a normal soft-start cycle. If V_{IN} should fall to the drop-out value of 12 to 13V, the chip switches back to its micropower status by gating off the reference, triggering the soft-start discharge circuit, and forcing the output driver to the low state.

The SG1528 includes a "hiccup" feature that protects the power device against excessive current during current-limiting operation. This feature permits the pulse-width modulator to go into a low-frequency mode of current limiting under severe overload conditions instead of the normal pulse-by-pulse current limiting. In the low-frequency mode, the power transistor switches lower average currents and dissipates less power. When the hiccup threshold is greater than the maximum output of the error amplifier but less than the maximum positive swing of the current amplifier, the soft-start circuit turns on. If severe overload conditions persist, the SG1528 slowly oscillates through soft-start cycles until fault correction occurs.

The voltage-error amplifier is a wideband op amp that uses standard feedback techniques to set the closed-loop gain and shape the frequency response. The current amplifier is a full-differential video amplifier that amplifies the voltage appearing across the sense resistor in series with the power-MOSFET source ter-

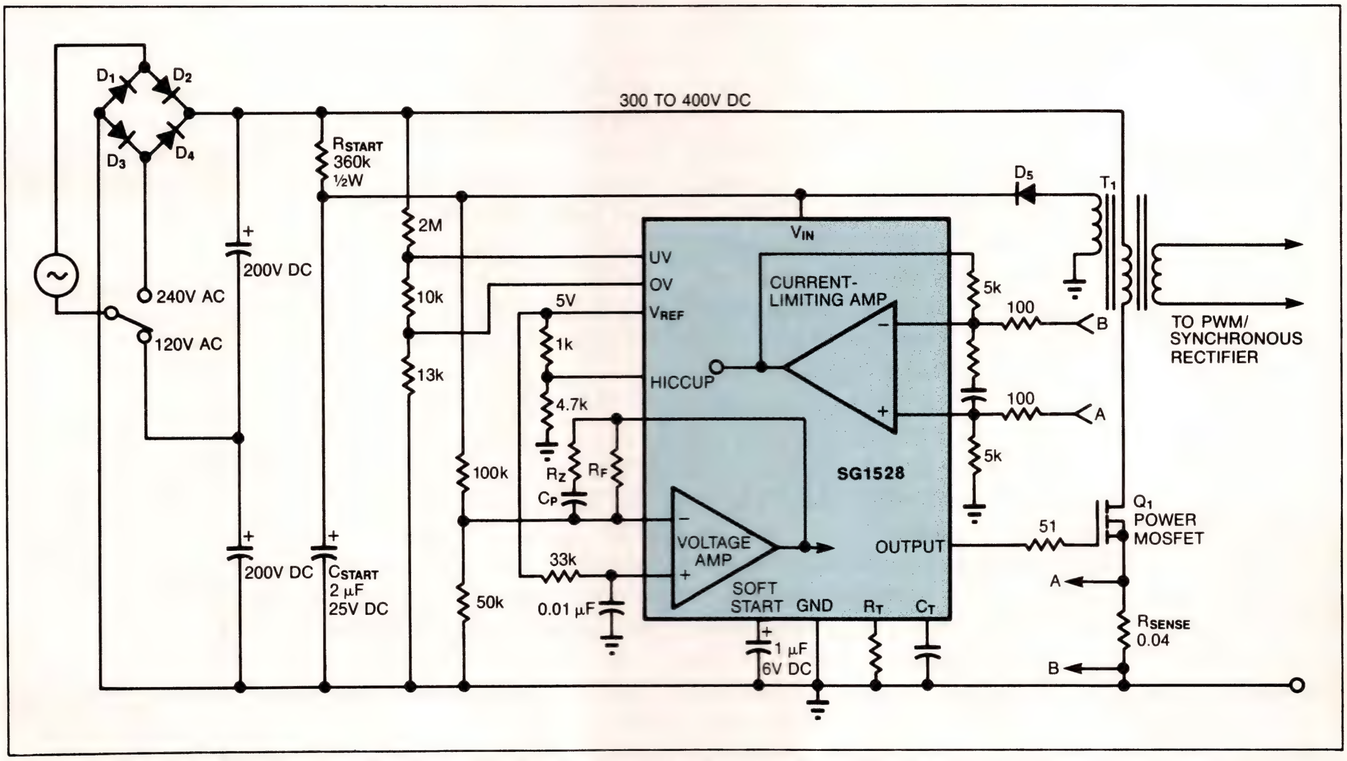


Fig 4—This circuit uses the SG1528, *from Silicon General, connected as a current-mode-control forward converter, although you can also use this device as a voltage-mode controller. The chip has a low-current start-up section, a "hiccup" circuit to protect the power device against excessive current, a wideband error amplifier, and a full-differential current amplifier.*

Overcoming the isolation barrier is an ongoing problem, but new chips are helping to provide a solution.

minal. The symmetrical input stage is essential for good high-frequency common-mode noise rejection.

A single chip provides all functions

Linear Technology Corp of Milpitas, CA, sells switching regulators that are more than just control circuits: They're actually self-contained building blocks that you can operate in all standard switching applications, including buck, boost, flyback, forward, and inverting configurations. Capable of delivering 100W, the LT1070 (5A) and LT1071 (2.5A) devices utilize current-mode switching techniques to provide line and load regulation. They each incorporate a high-efficiency power switch along with all oscillator, control, and protection features. The devices are available in either 5-pin TO-3 or TO-220 power packages.

In **Fig 5,** a functional block diagram of the LT1070, the output current directly controls the switch duty cycle. The output of a voltage-sensing error amplifier sets the current-trip level, thereby controlling the output voltage. This method has several advantages, including immediate response to input-voltage variations, reduction of the 90° phase shift at mid frequencies in the energy-storage inductor, and pulse-by-pulse current limiting. A low-dropout regulator supplies 2.3V for all internal circuitry and allows the input voltage to vary from 3 to 60V with little change in device performance.

The basic clock for all internal timing is a 40-kHz oscillator that turns on the output switch via the logic and driver circuits. A 1.2V bandgap reference connects to the positive input of the error amplifier. The negative input connects to an output-voltage-sensing pin.

A second function of this feedback pin, when pulled low by an external resistor, is to program the LT1070 to disconnect the main error-amplifier output and connect the output of the flyback amplifier to the comparator input. The LT1070 then regulates the value of the flyback pulse with respect to the supply voltage. In a transformer-coupled flyback regulator, this pulse is directly proportional to the output voltage. Thus, by regulating the amplitude of the flyback pulse, you can regulate the output voltage with no direct connection between the input and output. A special internal delay network ignores the leakage-inductance spike at the leading edge of the flyback pulse to improve regulation.

The signal developed at the comparator input connects externally to V_C. This pin has four functions: frequency compensation, current-limit adjustment, soft-start operation, and total regulator shutdown. During normal regulator operation, this pin sits at a voltage between 0.9 (low output current) and 2.0V (high output current). You can externally clamp this voltage to adjust the current limit. A capacitor-coupled external clamp provides the soft-start function. If you pull the V_C pin to ground through a diode, the switch duty cycle goes to zero, placing the LT1070 in an idle mode. Pulling the V_C pin below 0.15V causes total regulator shutdown, with only 50 μA of supply current for shutdown circuitry bias.

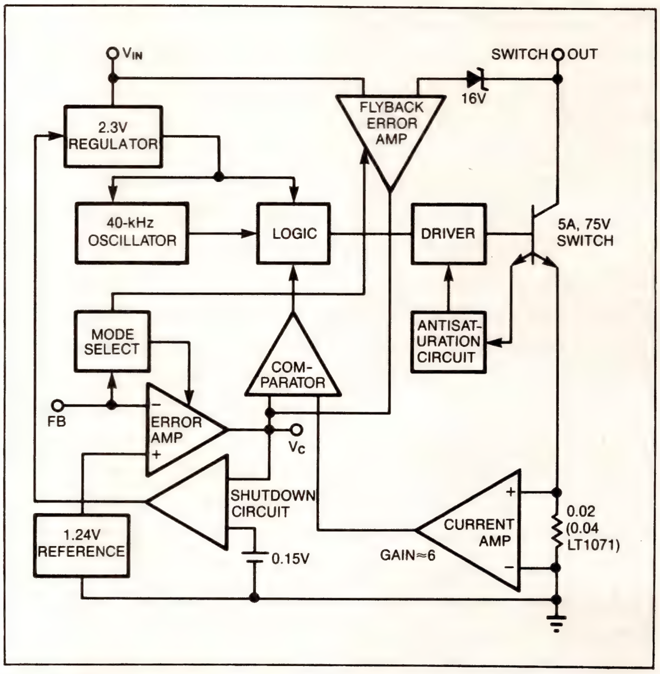


Fig 5—High-current operation is possible *with the LT1070 (5A) and LT1071 (2.5A) switching regulators from Linear Technology Corp. You can operate these devices in buck, boost, flyback, forward, and inverting switching configurations.*

IC is meant for telecommunications

A somewhat specialized current-mode controller is available from Motorola Semiconductor Products. The MC34129 allows remote digital telephones to derive their operating power directly from the twisted-pair cable used for data transmission. Although the device is primarily designed for telecommunications, you can also use it in many other converter applications.

In **Fig 6'**s block diagram of the internal circuit functions, the timing components R_T and C_T determine the oscillator frequency. For noise-sensitive applications, it may be desirable to synchronize one or more switching regulators to an external system clock, which you can do by applying the clock signal to the Sync/

Inhibit input. You can also use this input to shut down the system by applying a dc voltage that's within the range of 2V to V_{CC}.

The oscillator initiates the output-switch conduction. Conduction stops when the peak inductor current reaches a threshold level established by the output of the error amplifier or soft-start buffer. The error signal thus controls the peak inductor current on a cycle-by-cycle basis. Resistor R_S in series with the source terminal of output switch Q_1 converts the inductor current to a voltage. The error-amplifier output is in common with that of the soft-start buffer. These outputs are open-collector (sink only) and are connected in an OR arrangement at the inverting input of the PWM comparator.

In this arrangement, the amplifier that demands lower peak inductor current dominates control of the loop. Soft-start operation is mandatory for stable start-up when power comes from a high source impedance such as the long twisted-pair cable found in telecommunications applications. This operation effectively removes the load from the output of the switching power supply at initial start-up.

The MC34129 has a fault-timer circuit that prevents the unwanted occurrence of sustained operation during a lockout condition—a problem that frequently occurs with conventional switching control ICs operating from a high-impedance power source. If the required load power is greater than that available from the source, the input voltage will collapse, causing a lockout. The fault timer provides for automatic recovery by discharging the soft-start capacitor and initiating a soft-start

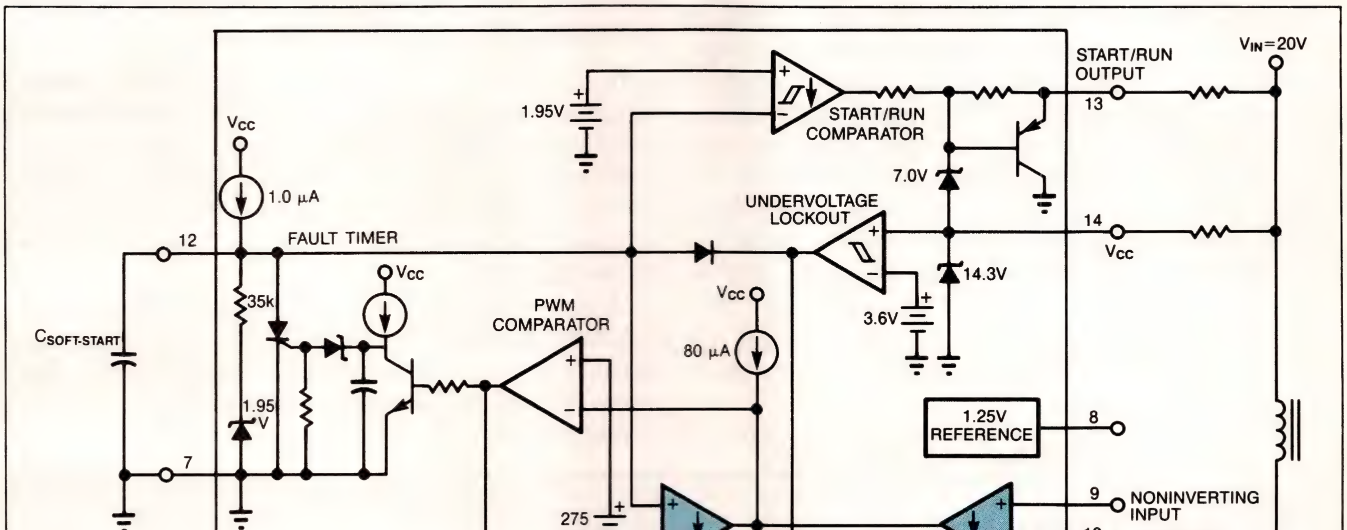


Fig 6—The MC34129 is a specialized current-mode controller for telecommunications applications. *The Motorola IC allows remote digital telephone systems to derive their power directly from the high-impedance twisted-pair cable used for data transmission.*

The direct control of the inductor current with minimum phase lag and inherent pulse-by-pulse current limiting are the main advantages of current-mode control.

cycle. The power supply will then operate in a skip-cycle or hiccup mode until a reduction occurs in either the load power or source impedance.

Furthermore, the MC34129 includes a start/run comparator, which you can use in a bootstrap start-up circuit to improve system efficiency when operating from a high input voltage. An undervoltage-lockout comparator ensures that the circuit is fully functional before enabling the output stage and initiating the soft-start cycle; the single totem-pole output stage is designed to directly drive power MOSFETs. It is capable of ±1A peak drive current and has a typical fall time of 30 nsec with a 500-pF load. The MC34129's totem-pole stage differs from most circuits in that it uses an npn transistor for turn-on drive and a high-speed SCR for turn-off. The SCR design requires less average supply current than an all npn-transistor type.

The main impetus behind resonant-mode control, as is true of voltage- and current-mode control, is the requirement for higher operating frequencies to reduce size and weight, particularly in military applications. Resonant-mode control ICs, however, use frequency modulation to provide regulation, in contrast to the others' use of conventional PWM. The LD405 from Linear Technology Inc of Ontario, Canada, holds the pulse width constant and varies the frequency over an operating range set by a resistor and a capacitor. The chip can operate at frequencies to 1 MHz, and it can drive power MOSFETs in either single-ended or push-pull circuits.

Included on-chip are peripheral functions such as soft-start, undervoltage/overvoltage lockout, remote shutdown, and overload shutdown with delayed-restart capabilities (**Fig 7**). Opening the normally grounded SEO control pin (pin 10) puts the LD405 into single-ended operation, doubling the output frequency and allowing you to parallel the two outputs for increased drive capability.

A capacitor from pin 11 to ground determines the minimum frequency of the VCO operating range, and a resistor from pin 14 to ground determines the maximum frequency. A capacitor and resistor in parallel, connected from pin 9 to ground, set the constant pulse

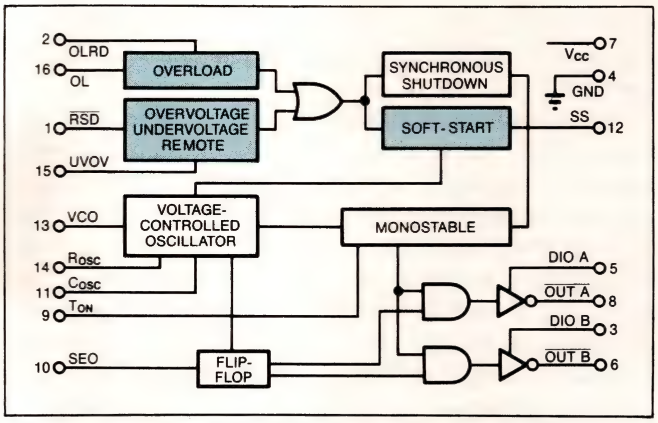


Fig 7—This circuit provides resonant-mode control of power supplies, *using frequency modulation, as opposed to pulse-width modulation, to achieve regulation. The Linear Technology Inc LD405's protective features include a soft-start function, an undervoltage/overvoltage lockout function, and an overload-shutdown function with delayed-restart capabilities.*

For more information . . .

For more information on the power-supply ICs discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Cherry Semiconductor Corp
2000 South County Trail
East Greenwich, RI 02818
(401) 885-3600
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Intersil Inc
10600 Ridgeview Ct
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Integrated Power Semiconductors Ltd
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(408) 727-2772
Circle No 356

Linear Technology Corp
1630 McCarthy Blvd
Milpitas, CA 95035
(408) 432-1900
Circle No 357

Linear Technology Inc
Box 489, Station A
Burlington, Ontario, Canada L7R-3Y3
(416) 632-2996
Circle No 358

Motorola Bipolar Analog Div
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Tempe, AZ 85283
(602) 897-3951
Circle No 359

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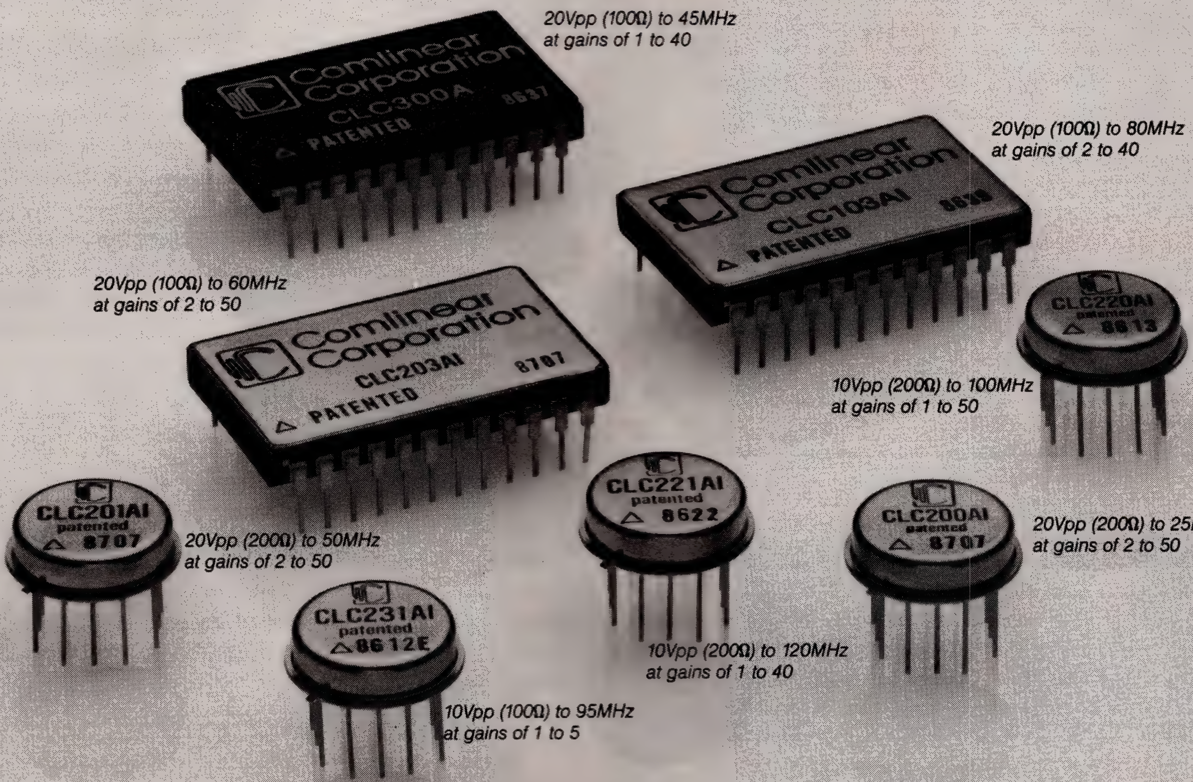

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General Purpose					
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CLC200	100	90	18	4000	12,100
CLC220	200	160	8	7000	12,50
CLC300	105	70	20	3000	10,100
Low Offset ($V_{OS} \leq 1mV$, $10\mu V/^{\circ}C$)					
CLC201	100	90	18	4000	12,100
CLC203	180	130	15 (to 0.2%)	6000	11,200
CLC221	200	120	15	6500	12,50
CLC231[1]	165 ($A_v = 1$)	120 ($A_v = 5$)	12	3000	11,100

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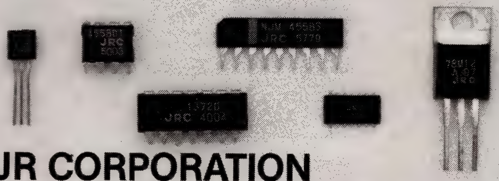

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width. The resistor's value should be between 5 kΩ and 20 kΩ; the capacitor's minimum value should be 50 pF. A capacitor from pin 12 to ground provides controlled start-up from minimum-to-maximum frequency. With a capacitor value of 2.2 μF, this delay is approximately 20 msec.

To provide isolation, the VCO input (pin 13) works with an optocoupler feedback network from the secondary (output) side of the power supply. The chip includes a 10-kΩ pullup resistor at this pin, but you can connect a lower-value external resistor if required. Pin 15 is the input to a window comparator that provides the undervoltage/overvoltage function. A higher or lower voltage than the specified threshold will shut the power supply down until the input voltage falls within the window again. At this point, the LD405 reverts to the soft-start mode. Pin 16 is the overload input; a voltage exceeding the specified threshold will cause the circuit to shut down and activate the overload restart-delay function.

Normally you set the IC's maximum frequency in the range of 300 kHz to 1000 kHz to obtain the benefits of high-frequency performance. The ratio of maximum frequency to minimum frequency is 75:1 (typ), with a floor of 10 kHz for the minimum frequency. An LC-tuned circuit in the primary side of the switching transformer resonates at a frequency somewhat higher than the maximum frequency selected. **EDN**

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Max. Sweep Speed	500 psec	500 psec	500 psec	500 psec	1 nsec
Vertical Sensitivity	2 mV/div	2 mV/div	2 mV/div	2 mV/div	2 mV/div
Trigger Frequency	500 MHz	500 MHz	500 MHz	500 MHz	250 MHz
GPIB	Standard	Standard	Standard	Optional	Optional
Counter/Timer/Trigger/Word Recognizer	Standard	Standard	Standard	Optional	Optional
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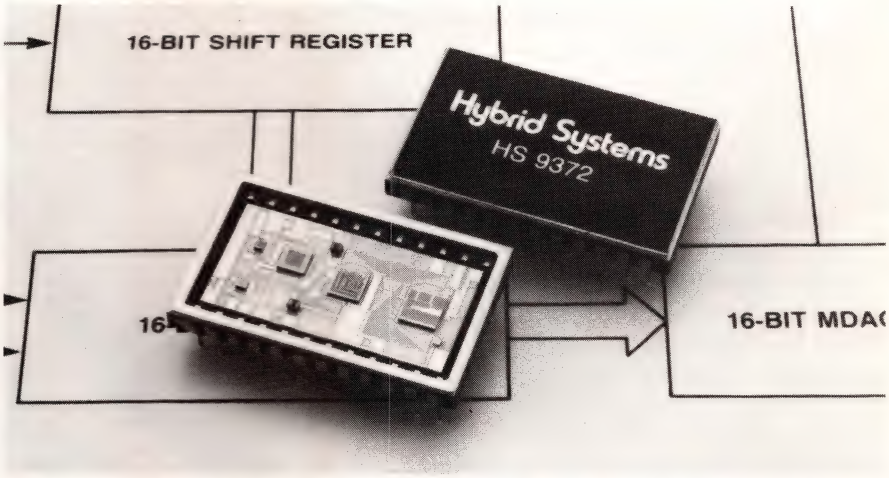


The HS9372 multichip-hybrid D/A converter guarantees monotonicity to a resolution of 16 bits over the commercial or military temperature ranges. This multiplying DAC accepts a serial input and dissipates only 50 mW max.

The ensured monotonicity of the converter stems from a segmented decoding technique. In this method, the DAC divides the four MSBs into 15 equal-weight switches instead of the usual four binary-weighted switches. This configuration reduces linearity errors and output-amplifier (external) offset errors by a factor of eight. A traditional R-2R network provides the remaining 12 bits.

According to the manufacturer, the DAC contains a semicustom gate array that minimizes digital feedthrough (capacitive coupling of the input's transitions to the output). The hybrid contains decoupling capacitors to reduce the effects of power-supply perturbations. Data loads serially into a shift register. The 16-bit word then loads into a latch prior to its conversion to an analog output. A clear input allows you to set the DAC's latch asynchronously to either all zeros or a one (the MSB) and all zeros.

Specifications for the converter include ±0.003% (±1 LSB at 15 bits) max integral nonlinearity over the full temperature range and ±0.0015% or ±0.003% max differential nonlinearity, depending on the grade. Housed in a 24-pin plastic or ceramic DIP, the HS9372 costs from $48 to $150 (100).

Hybrid Systems Corp, 22 Linnell Circle, Billerica, MA 01821. Phone (617) 667-8700.

Circle No 607

Voice-compression chip doubles capacity of 64k-bps full-duplex telephone links

The DS2167 combines a digital signal processor (DSP) with an algorithm known as Adaptive Differential Pulse Code Modulation (ADPCM) on a single chip. The result is a voice-transmission rate of 32k bps, which effectively doubles the capacity of 64k-bps full-duplex telephone links.

The ADPCM algorithm allows the DS2167 to conform to the latest CCITT standards while dividing the bit rate for standard speech transmission. The algorithm was developed by CCITT and enhanced by T1Y1 (a North American standards body) to facilitate full-duplex compression and expansion of a voice channel.

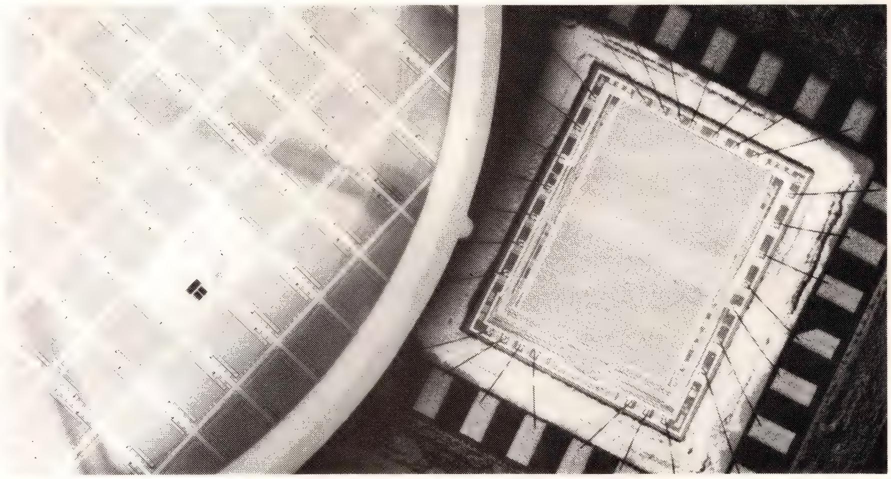
In T1 networks, the DS2167 doubles the transmission capability of existing equipment without any need for extensive modification. Thus, you can expand your 24-voice-channel T1 line to accommodate 48 channels by splicing one DS2167 chip per voice channel into each end of the T1 line.

You can also use this chip to integrate voice and data services. The DS2167 offers transmission capabilities that are similar to the Integrated Services Digital Network (ISDN), because the reduced voice-transmission bandwidth lets you combine voice and data transmission on a single line. Such a voice-compression function previously required an entire pc board of electronics. The 24-pin CMOS IC consumes less than 150 mW and costs $39 (1000).

Dallas Semiconductor Inc, 4350 Beltwood Parkway, Dallas, TX 75234. Phone (214) 450-0446.

Circle No 613

DSP family supports real-time processing at throughput rates to 20M samples/sec



The MA7100 Signal Stream DSP chips handle 10-bit data at throughput rates as high as 20M samples/sec, allowing you to build a DSP system with a dynamic range of 60 dB and a bandwidth of 10 MHz.

The family includes both algorithm-specific DSP ICs for linear and nonlinear filtering, and support ICs that allow you to combine devices to produce more complex DSP functions. The algorithm-specific DSP ICs comprise the MA7180 1- or 2-dimensional convolver and the MA7190 rank-order filter. The support devices include the MA7188 cascade ALU and the MA7186 video line buffer.

The MA7180 convolver performs a 2-dimensional convolution (sum of coefficient/data product pairs) on a 3×3 array of 10-bit data values with 8-bit coefficients, producing a 22-bit result.

By adding one or more MA7186 video line buffers, you can perform 2-dimensional convolutions in real time, while a video image is being scanned. Each MA7186 can store two 64-, 128-, 256-, or 512-pixel scan lines or one 1024-pixel scan line. To implement functions that require nonlinear filters—functions such as spot-noise removal or background-level estimation—you can use the MA7190 rank-order filter.

The MA7180, MA7190, and MA7188 are available in 68-pin leadless chip carriers or pin-grid arrays; the MA7186 is available in a 48-pin DIP or leadless chip carrier. Pricing for the parts is approximately £200 for the MA7180, £150 for the MA7190, £50 for the MA7188, and £40 (1000) for the MA7186.

Marconi Electronic Devices Ltd, IC Div, Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

Circle No 617

Marconi Electronic Devices Inc, 45 Davids Dr, Hauppauge, NY 11788. Phone (516) 231-7710.

Circle No 618

2k×8- and 4k×8-bit CMOS EEPROMs feature 35-nsec max access time

The 38C16 and 38C32 2k×8-bit and 4k×8-bit high-speed CMOS EEPROMs operate from one 5V supply. The chips' maximum address-access time is 35 nsec, and their chip-enable and output-enable times are both 20 nsec.

To write data to one of these devices, you use the EEPROM as you would any RAM. The internal address and data latches latch the inputs during the high-speed portion of the process. The internal circuitry of the 38C16/32 keeps the address and data stable for the required 5 msec.

The EEPROM family also includes the 36C16 and 36C32, which can replace bipolar PROMs. These devices also have a 35-nsec maximum address-access time, but they don't have the on-chip latches for use during writing.

The endurance specification for the 38C16/32 and 36C16/32 states that a maximum of 1% of the devices will fail before reaching 10,000 cycles.

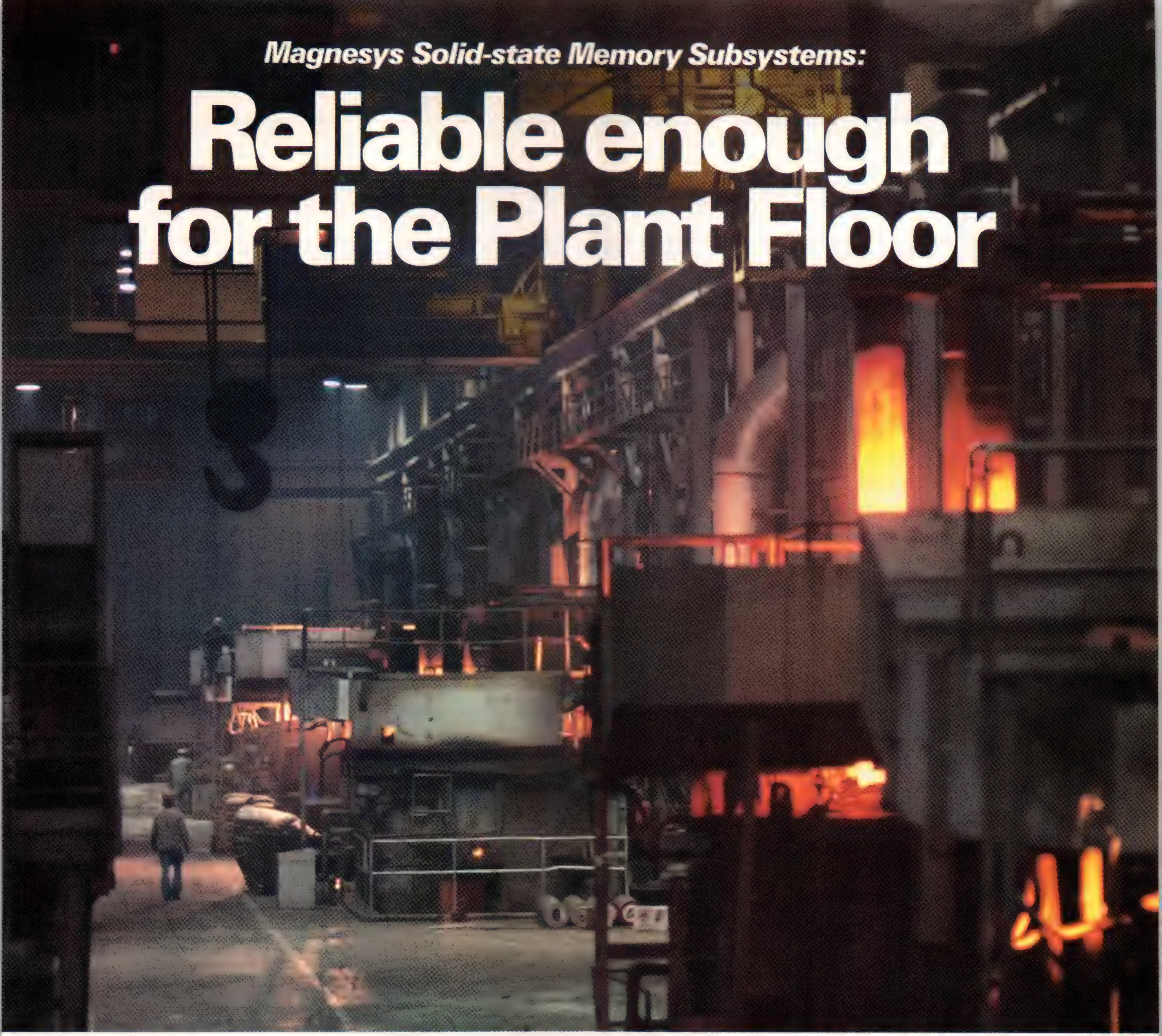
OEM quantities will be available by the fourth quarter of 1987. The 38C16 and 38C32 cost $27 and $38, respectively; the 36C16 and 36C32 cost $18 and $30 (100).

Seeq Technology Inc, 1849 Fortune Dr, San Jose, CA 95131. Phone (408) 432-9550. TWX 910-338-2313.

Circle No 627

Magnesys Solid-state Memory Subsystems:

Reliable enough for the Plant Floor



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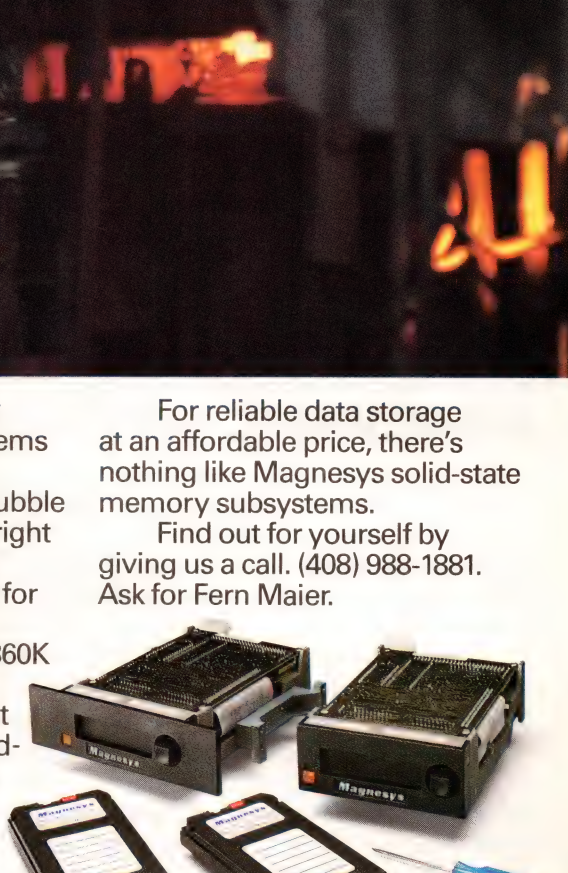

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*Multibus is a registered trademark of Intel Corp.
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Magnesys

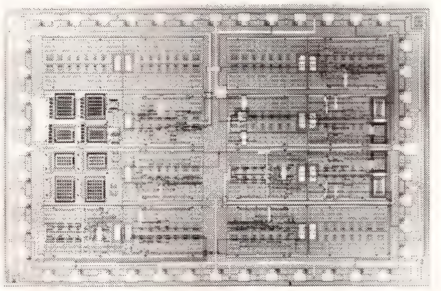
1605 Wyatt Drive, Santa Clara, CA 95054

CIRCLE NO 88

Semicustom linear arrays feature high-frequency vertical pnp transistors

Because they incorporate vertical pnp transistors, the ALA semicustom linear arrays offer better high-frequency performance and faster speeds than similar arrays that have lateral pnp transistors. At present, the ALA family has three members, which consist of uncommitted vertical npn and pnp transistors, MOS capacitors, and diffused and/or ion-implanted resistors. All the inputs and outputs have ESD protection.

The ALA200 UHF (12V) array provides an f_T of 4 GHz for the npn transistors and 2.5 GHz for the pnp transistors. The chip is divided into 12 modules, which are organized symmetrically, and contains 133 npn transistors: 85 pnp transistors, 982 boron-implanted resistors, and 22 capacitors. Capacitor values of all but two are programmable from 1 to 5 pF.



The ALA300/301 have a 90V breakdown capability. The 1-module version (300) consists of 13 vertical npn and 15 vertical pnp transistors, three 6-pF capacitors, and 108 resistors located in 1k diffused and 10k ion-implanted resistor banks. The 301 model has four times the number of components as the ALA300 but is otherwise identical. The typical f_T is 350 MHz for the npn transistors and 300 MHz for the pnp transistors.

The general-purpose ALA400 has a 30V breakdown voltage. Its typical f_T is 350 MHz for the npn transistors, 300 MHz for the pnp transistors. Its 100 npn transistors include four power types capable of handling >70 mA. The array also has 100 pnp transistors. The resistor complement includes 272 diffused and 384 ion-implanted types.

Nonrecurring engineering (NRE) charges vary from $10,000 to $30,000. ALA200, $14.35; ALA300, $1.40; ALA301, $4.65; ALA400, $2.15. In 16-pin DIPs, the chips cost $17.10, $2.20, $5.95, and $3.05, respectively (all 10,000). Delivery of prototypes, four to eight weeks. Production lead-time after the sample approval, six to eight weeks.

AT&T Technologies, 555 Union Blvd, Dept 50AL203140, Allentown, PA 18103. Phone (800) 372-2447.

Circle No 628

Monolithic 16-bit ADC has no missing codes to 50 kHz

The CS5016 CMOS A/D converter provides a true 16-bit digital representation of a bipolar or unipolar analog signal in 16 μsec at sampling rates reaching 50 kHz. The converter also features a self-calibration circuit that ensures maximum nonlinearity of ±0.001% of full-scale range over the temperature range. It specs no missing codes at 16 bits. Offset and full-scale errors are ±¾ LSB max, so you don't need to perform any manual calibration.

You can configure, control, and monitor the CS5016 via its on-chip μP interface, or you can operate the chip independently of intelligent control. An input track/hold function that's inherent in the device's sampling architecture acquires an analog signal within 4 μsec after each conversion, so the converter provides throughput rates as high as 50 kHz.

The converter uses the successive-approximation technique. The conversion consists of manipulating the free plates of the capacitor array to either V_{REF} or AGND, so as to arrive at a binary fraction of capacitance that represents the converter's digital output.

A 14-bit version of the chip, the CS5014, specs maximum nonlinearity of ±0.003% of full-scale range, over temperature, at throughput rates to 50 kHz. The CS5014 maintains offset and full-scale errors within ±½ LSB (max). The CS5014 and CS5016 both come in versions specified for use over 0 to 70°C, −40 to +85°C, and −55 to +125°C. The CS5014, from $45; the CS5016, from $69 (100).

Crystal Semiconductor Corp, Box 17847, Austin, TX 78760. Phone (512) 445-7222. TWX 910-874-1352.

Circle No 609

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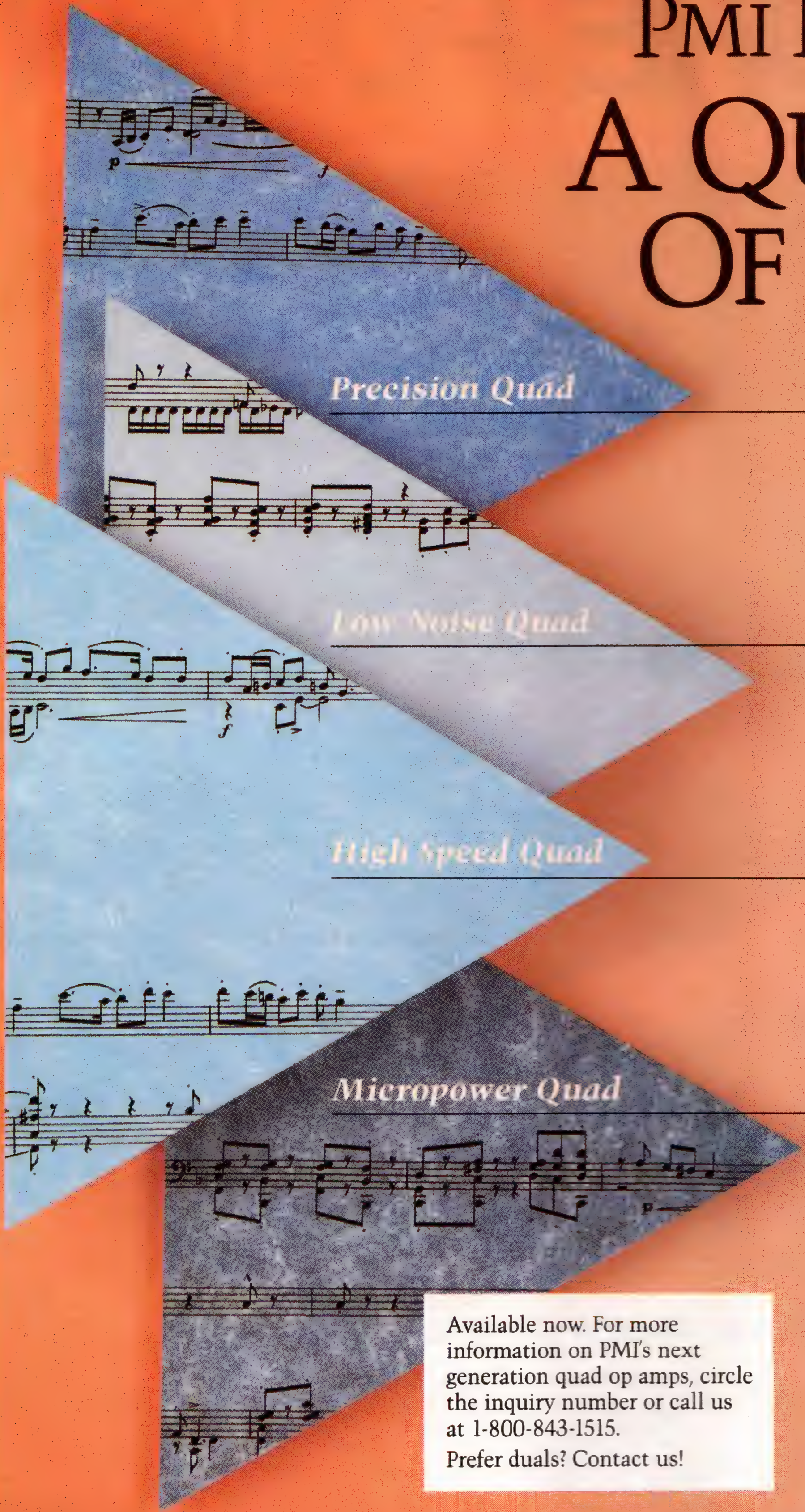

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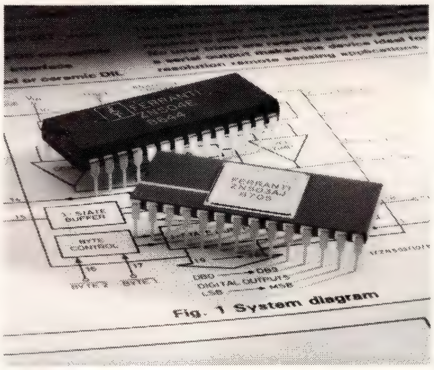
μP-compatible A/D converter suits remote-sensing applications



The ZN503 and ZN504 monolithic 10-bit successive approximation A/D converters feature parallel and serial 3-state outputs. The serial output suits the devices for use in remote sensing applications by reducing wiring requirements. You can configure the device's TTL/CMOS-compatible parallel interface for 8- or 16-bit operation. Only two external components are required for operation, and the converter needs no trimming.

The ZN503 operates over the military temperature range (−55 to +125 °C) and has a linearity specification of ±0.5 LSB; the ZN504, available for operation over the commercial temperature range (0 to 70 °C), has a linearity specification of ±1 LSB. For both devices, the maximum differential nonlinearity is ±0.5 LSB, the maximum dc offset is ±2 LSB, and the typical gain error is ±4 LSB. The devices have an on-chip 2.5V precision voltage reference, and are pin-programmable to provide input ranges of 0 to 2.5V, 0 to 5V, or −2.5 to +2.5V. Maximum conversion time is 20 μsec.

Housed in a 28-pin ceramic DIP, the ZN503 costs £22.27 (100). The ZN504 is available in a 28-pin ceramic or plastic DIP, priced at £14.18 and £9.45 (100), respectively.

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham, Lancashire OL9 8NP, UK. Phone 061-624 0515. TLX 668038.

Circle No 624

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

Circle No 625

Single-chip frequency synthesizer suits mobile-radio applications

Featuring a typical current consumption of 1.5 mA, the TDD1742T single-chip frequency synthesizer is suited for use in portable, multichannel VHF and UHF radio transceivers. The single IC includes programmable dividers for both reference and VCO frequencies, phase comparators, and a switchable phase modulator. The synthesizer meets all the requirements of the Amps (Advanced mobile phone system) and Tacs (Total access communication system) 900-MHz cellular-radio standards.

Driven by a crystal or external frequency source in the range 1 to 9 MHz, the programmable reference divider produces division ratios between 240 and 4320 to provide all the required VHF and UHF channel spacings. The VCO output divider accepts input frequencies as high as 8.5 MHz and incorporates feedback to control an external prescaler.

The output from the synthesizer's digital phase comparator provides fast initial locking of the VCO during channel switching. For example, the synthesizer can achieve a channel-switching speed of 8 msec for a channel width of 25 kHz. After the initial locking, a high-gain analog phase comparator takes over from the digital phase comparator to ensure low-noise output levels. The analog comparator also produces an out-of-lock signal that you can use for muting purposes.

You can program the TDD1742T from a microprocessor or microcontroller. Or you can make the synthesizer automatically fetch its programming information from an external 4-bit-wide PROM. The TDD1742T operates from a 7 to 10V supply voltage and is housed in a 28-pin surface-mount plastic miniature DIP. The low-volume price for the part is around $20.

Philips Elcoma Division, Box 523 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 620

Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

Circle No 621

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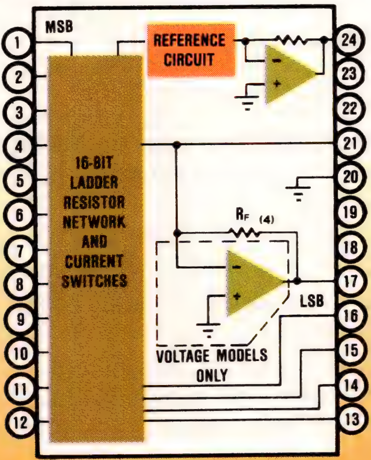

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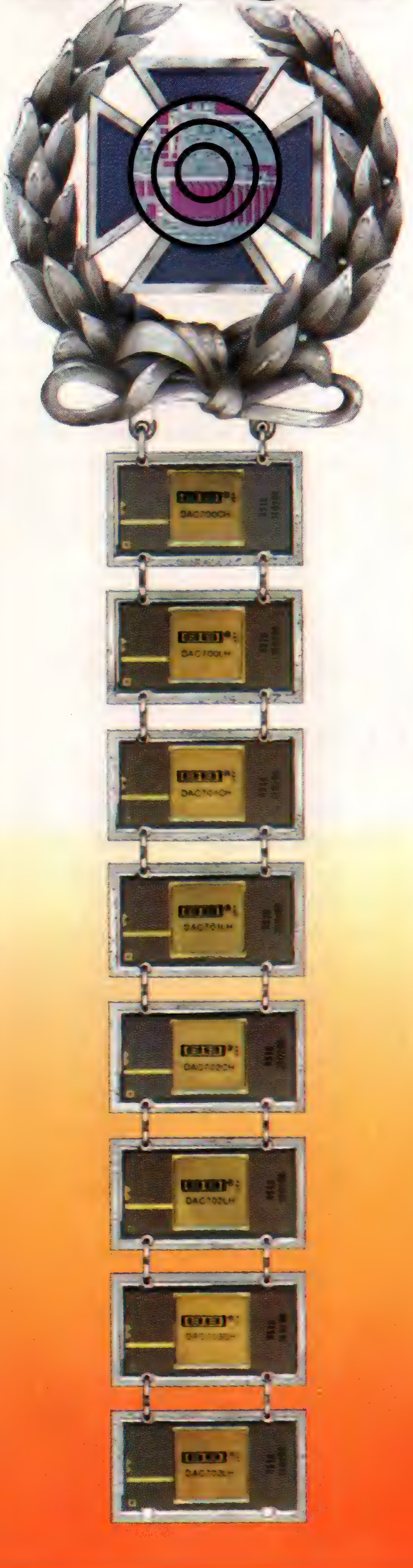

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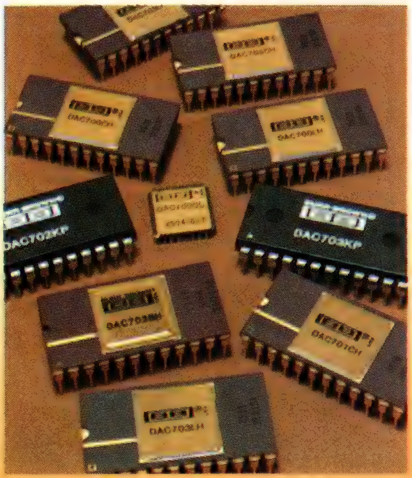

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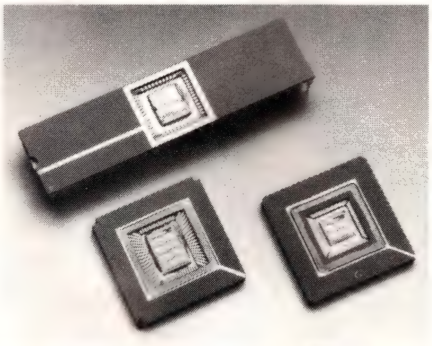
CIRCLE NO 86

BURR-BROWN®

Improving Data Conversion Productivity

Vector signal-processor suits cost-sensitive applications



The ZR34161-10 (or VSP-10) vector signal-processor is a low-cost ($155) version of the VSP-20 DSP chip. It can perform a 1024-point complex-integer FFT in 4.8 msec, which represents real-time processing for a system operating with a sample rate as high as 200k samples/sec. It can perform the same calculation, using block floating-point arithmetic, in 6.6 msec.

Using fixed-point arithmetic, the results of the ALU are scaled (divided by two) at the end of each FFT pass. This division eliminates the possibility of overflow during the addition required for the FFT butterfly. With block floating-point arithmetic, the results of ALU operations at the end of each FFT pass are scaled only if an overflow has occurred. This way the block floating-point operation retains the precision of the input signal during computations by not performing right-shifts because it performs right-shifts only when an overflow occurs. Block floating-point arithmetic allows the vector signal-processor to process signals having an extremely wide dynamic range.

Specific DSP algorithms, such as FFT and digital filtering, are embedded in the processor as high-level functions.

Two IBM PC-compatible evaluation boards are also available: The VSPX contains a VSP-10 and costs $1000 (1000). The VSPE incorporates a VSP-20 and costs $1800. The VSP-10 itself is $155; an assembler for the chip lists at $250.

Zoran Corp, 3450 Central Expressway, Santa Clara, CA 95051. Phone (408) 720-0444.

Circle No 631

Multiplier and ALU chip set executes 100 MIPS

The B3110/B3120 floating-point chip set executes 60M nonpipelined, 64-bit floating-point operations per second. The set consists of a multiplier and an arithmetic logic unit (ALU), and it supports both the IEEE-754 and the DEC F and G floating-point formats.

The multiplier performs single-precision (32-bit) or double-precision (64-bit) floating-point multiplication, division, square-root calculation, or 32×32-bit integer multiplication in a single cycle. Its division and square-root instructions don't require external seed or lookup-table storage. The chip accomplishes single-precision multiplication in 35 nsec and double-precision multiplication in 45 nsec. It calculates square roots in as little as 170 nsec (single precision) or 325 nsec (double precision). Its worst-case division times are 105 nsec and 180 nsec for single and double precision, respectively.

The ALU's instruction repertoire includes add, subtract, integer shift, rotate, and arithmetic or Boolean operations on 32- or 64-bit integers in a single cycle. It executes integer operations in 10 nsec and floating-point operations in 25 nsec. The multiplier and the ALU incorporate 63,000 and 65,000 transistors, respectively.

The chip set uses a flow-through architecture instead of a pipelined approach. One disadvantage of pipelining is that it requires multiple cycles in order to generate results. Another problem is that the controlling software must manage the pipeline stages. The flow-through architecture skirts these problems by completing every operation in a single cycle.

The chip set incorporates error-checking features, which include parity generation and checking against data ports. Scan paths are also provided on all registers.

The B3110 floating-point multiplier and B3120 ALU are compatible with 10KH ECL parts; they cost $640. The B2110 and B2120 are the TTL versions of the multiplier and ALU and sell for $490.

Bipolar Integrated Technology, 1050 NW Compton Dr, Beaverton, OR 97006. Phone (503) 629-5490.

Circle No 611

“**EDN NEWS** *PROVIDED AN OVERWHELMING RESPONSE OF HIGH-QUALITY LEADS FOR OUR MICRO PEDESTAL ENCLOSURE.*”

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Sales Manager
Everest Electronic Equipment, Inc.

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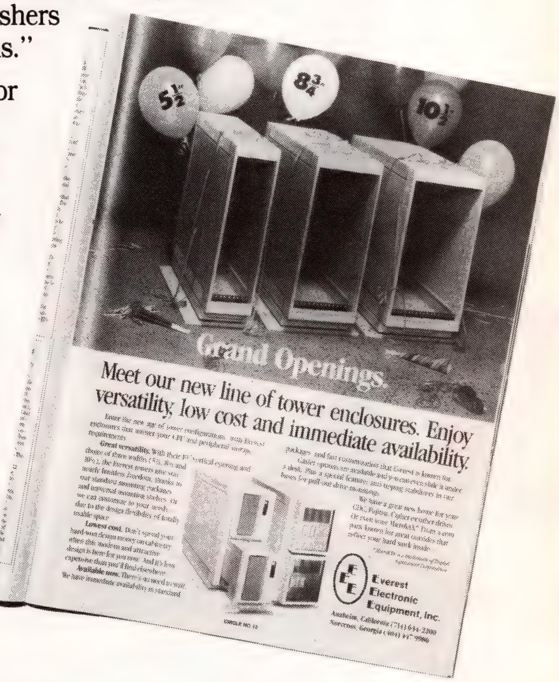
“Everest has a reputation for high-quality enclosure products,” says Holman, “and EDN News has brought us more than 170 high-quality leads. We consider the association a tremendous success!”



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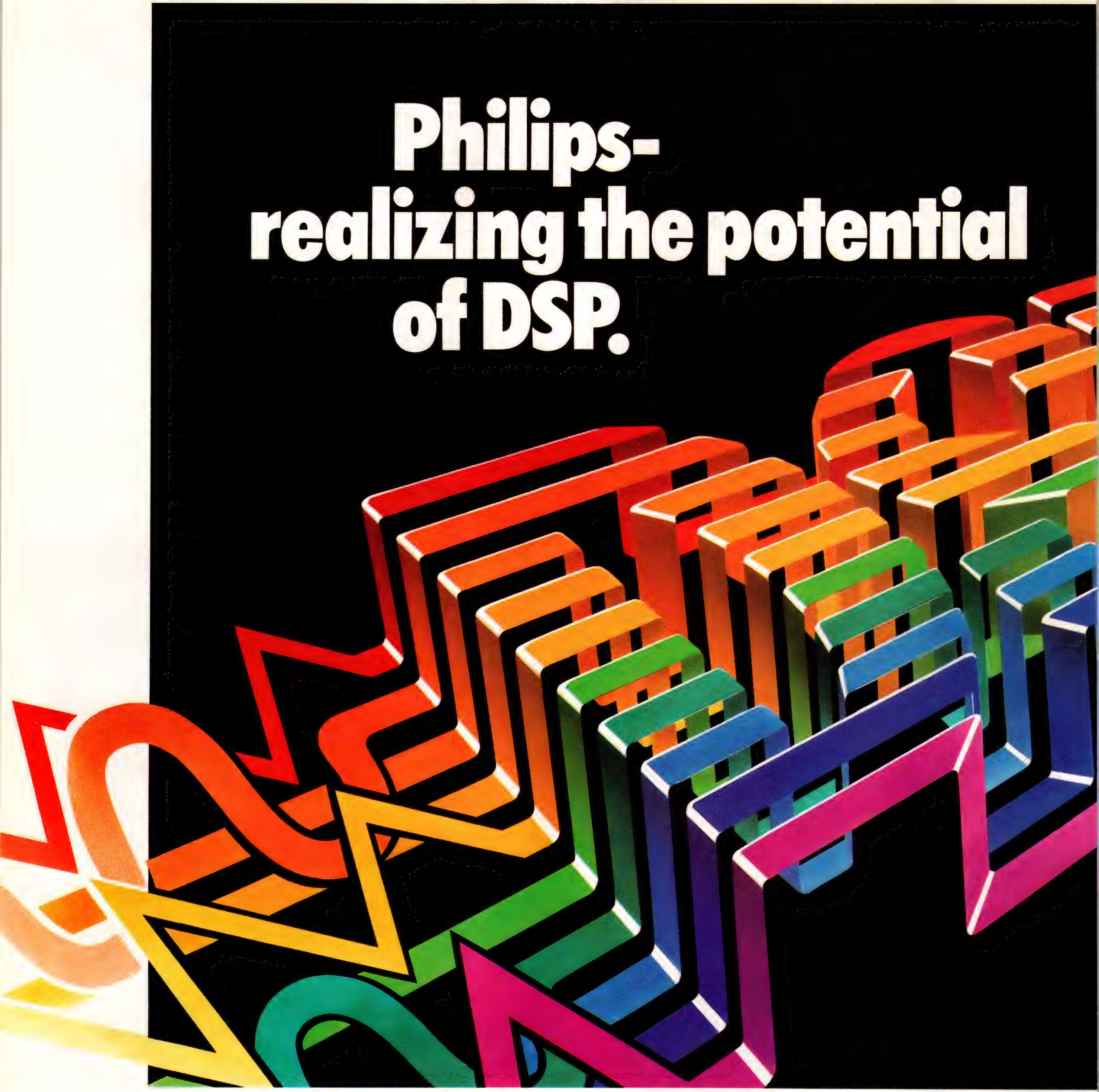

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- two serial input channels
- two serial output channels
- one or two 16-bit parallel data ports:– 16, or 16 and 9-bit addressing
- maskable interrupt
- instruction repeat mechanism
- instruction and coefficient ROM (PCB5010) and ROMless (PCB5011) versions

Development support:
- Cross-assembler
- screen-oriented simulator with ILS interfaces
- extensive source-code-accessible library of filters FFTs etc.
- stand-alone real-time emulator
- application notes

Application highlights:
- Fast filter and FFT kernels with amazingly little overhead for initialization and I/O
- easy multi-DSP implementation via flexible I/O capabilities
- combined DSP and controller use by means of separate ALU

Please send me full details of Philips DSPs

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Building BA, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtc/nl

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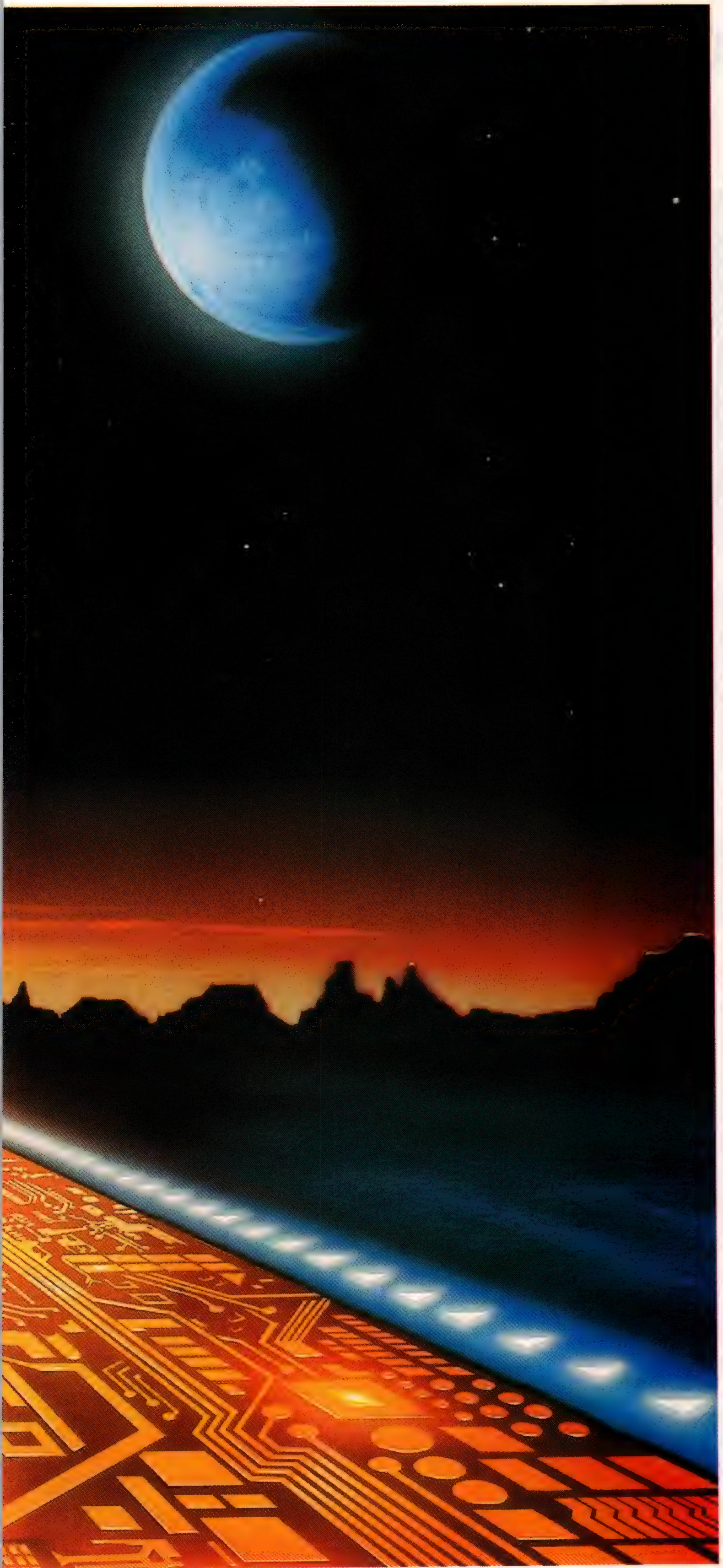

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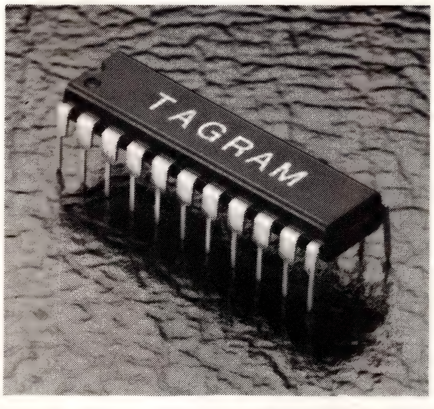
20-nsec cache RAM features on-chip comparator

Eliminating any need for an external comparator circuit, the MK41H80 Tagram, a 4k×4-bit static RAM, is suitable for use in cache-tag applications. The chip contains a 4-bit comparator that compares RAM contents to current input data in as little as 12 nsec.

The MK41H80 compares the contents of addressed RAM locations to current data inputs. An output of logical one on the chip's Match pin indicates that the input data and the RAM contents match. You can connect the Match pins of several Tagrams to provide Enable or Acknowledge signals to a data cache or μP.



The part's Flash Clear feature lets you clear all RAM bits to logical zero in 40 nsec or less. The Tagram also gives you full-speed read access to the RAM's contents, thus reducing the possibility that the Tagram will induce delays in circuits controlled by high-speed μPs.

You can order the Tagram with an address- and match-access time as low as 20 nsec. Other versions spec 25- and 35-nsec access times. The Tagram operates from a single 5V power supply. Its inputs and outputs are TTL compatible and are protected against static discharge. Available in a 22-pin, 300-mil plastic or ceramic DIP, the Tagram ranges in price from $10.19 to $22.50 (100).

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, TX 75006. Phone (214) 466-6000. TLX 730643.

Circle No 612

Parallel/serial FIFO memory includes support circuits to ease buffer design

To create its IDT72103 and IDT72104 CMOS parallel/serial FIFO memories, the vendor has placed much of the necessary support circuitry—including shift registers and control logic—on chip. You can use both devices in parallel-to-parallel, parallel-to-serial, serial-to-parallel, or serial-to-serial configurations.

The FIFO memories are configured as 2048 words×9 bits and 4096 words×9 bits, respectively. The ICs' serial input and output circuitry includes what the manufacturer refers to as the Flexishift feature, which allows you to program the serial word length from four bits to any number of bits without adding external logic.

You can expand the word beyond nine bits by using more than one FIFO memory. The FIFO memories include on-chip control signals and logic that allow you to expand word width, depth, or both without adding external circuitry.

The standard flags available in a FIFO memory are the Empty and Full flags; many FIFO memories also include Half Full flags. The IDT72103 and IDT72104 have these as well as a few extra flags: the Full−1, Empty+1, and Almost Empty/Full flags. The Full−1 and Empty+1 flags indicate that the FIFO buffer has only one vacant or one filled location, respectively. Depending on the status of the Half Full flag, the Almost Empty/Full flag indicates that the FIFO buffer is either less than ⅛ full or more than ⅞ full.

Both devices have a parallel-port access time of 50 nsec and allow a serial I/O frequency of as much as 40 MHz. Access to the RAM array is asynchronous, so the chips can perform simultaneous read and write operations. In the single-device mode, the FIFO memories have a retransmission capability.

An IDT72103 in a commercial-grade plastic DIP costs $37; in the same package, the IDT72104 sells for $55 (100). Versions screened to MIL-STD-883 are also available.

Integrated Device Technology Inc, 3236 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-6116. TWX 910-338-2070.

Circle No 616

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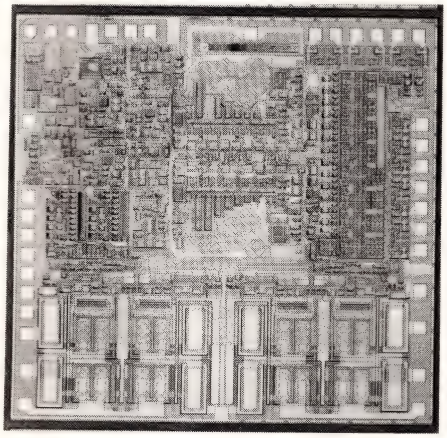
CIRCLE NO 84

Motor-driver ICs provide high-resolution microstepping

By controlling the current in each phase-winding of a bipolar stepper motor, the L6217 and L6217A stepper-motor driver ICs allow you to subdivide the motor's step interval into 64 or 128 microsteps, respectively. In addition to providing control circuitry, the ICs also contain H-bridge output stages that can drive as much as 500 mA into each winding. For higher current applications, the devices can control external H-bridge drivers.

Two D/A converters (6-bit in the L6217 and 7-bit in the L6217A) are provided to set the winding current. Each converter is monotonic to ±½ LSB and has a linearity of ±1 LSB. An additional control bit determines the direction of the winding current. The control inputs, which are TTL-compatible and internally latched, interface directly to the external memory bus or an I/O port of 8051- or Z8-family microcontrollers.



For accurate current control, external resistors sense the actual winding currents, which are then compared with the D/A output in on-chip comparators. Modulating the frequency then corrects any error involving the switching of the H-bridge. External RC networks allow you to control the off-period of the switching. The H-bridge outputs incorporate integral fast recovery diodes to control switching voltage transients.

Additional on-chip functions include a precision voltage reference for the D/A converters, thermal-overload protection circuitry, and reset circuitry suitable for driving a microcontroller.

Both the L6217 and L6217A are housed in 44-pin plastic leaded chip carriers, which have 11 leads devoted to heatsinking the device. Less than $5 (10,000).

SGS-Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 622

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 623

8-bit μC employs nonvolatile RAM to offer crashproof operation

The DS5000 Soft Microcontroller features an 8-bit CPU, on-chip encryption logic, 8k or 32k bytes of nonvolatile high-speed static RAM, a serial I/O port, 32 parallel I/O lines, and two 16-bit event counter/timers.

Operating at 8-, 10-, and 12-MHz clock rates, the CMOS device is pin compatible with Intel's 8051 microcontroller and uses the same instruction set. Thus, you can develop new designs for the DS5000 by using development tools and software packages that are currently available for the 8051 architecture.

To prevent system crashes caused by low operating voltage, the DS5000 automatically halts processor operation when it detects low input voltage. The chip's lithium energy source backs up all device data, including internal registers, configuration data, and key variables. Upon restoration of the input voltage, the microcontroller automatically boots and resumes its application-software processing. An on-chip watchdog timer monitors software execution and automatically resets the processor in the event of a software malfunction.

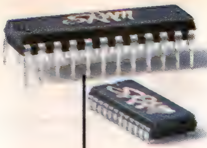
The microcontroller provides software security by encrypting data according to an internal 40-bit key word. If someone attempts to read the key word by resetting the security-lock bit, the chip automatically erases the key word, making the RAM contents indecipherable and preventing the program from running.

The DS5000 operates in temperatures ranging from 0 to 70°C. Its lithium power source provides more than 10 years of data protection. The 32k-byte version costs $78 (100). With 8k bytes of RAM, the DS5000 sells for $59 (100).

Dallas Semiconductor Inc, 4350 Beltwood Parkway, Dallas, TX 75244. Phone (214) 450-0400.

Circle No 615

Increasing Static RAM Speeds for High Density Applications.



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			Access Time (ns)									Package Options*		
Density	Organization	Part No.	25	35	45	55	70	85	100	120	150	PDIP	SOIC	SOJ
16K	16K X 1	M5M21C67		●	●	●						●		
	4K X 4	M5M21C68		●	●	●						●		
64K	64K X 1	M5M5187			●	●						●		
		M5M5187A	●	●								●		●
	16K X 4	M5M5188			●	●						●		
		M5M5188A	●	●								●		●
		M5M5189A	●	●								●		●
	8K X 8	M5M5165					●		●	●	●	●	●	
		M5M5178		●	●	●						●		
72K	8K X 9	M5M5179		●	●	●						●		
256K	256K X 1	M5M5257		●	●	●						●		●
	64K X 4	M5M5258		●	●	●						●		●
	32K X 8	M5M5256							●	●	●	●	●	
		M5M5255					●	●	●			●	●	
		M5M5256A					●	●	●			●	●	
1M	128K X 8	MH12808TNA						●	●	●	●	DIP MODULE		
2M	256K X 8	MH25608S1N					●	●	●	●	●	SIM MODULE		

*PDIP: Plastic Dip SOIC: Small-Outline Gull-Wing SOJ: Small-Outline J-Lead

Catch the future now for high performance static RAM applications. Call or write today: Mitsubishi Electronics America, Inc., Semiconductor Division, 1050 East Arques Avenue, Sunnyvale, CA 94086. (408) 730-5900, ext. 2314.

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CIRCLE NO 83

Low-power data-acquisition system resides on a single CMOS chip

The ML2200 low-power CMOS chip includes a 13-bit A/D converter (12 bits plus sign), a 4-channel differential multiplexer, a programmable-gain instrumentation amplifier, an S/H amplifier, a voltage reference, and a digital-control section that can perform many data-acquisition tasks.

The 13-bit A/D converter is a self-calibrating design that doesn't require any external trimming devices. It converts 13 bits at 40 kHz max and eight bits at 50 kHz max. At a 13-bit resolution, the converter's integral and differential nonlinearity spec of ±½ LSB is guaranteed over temperature, power-supply range, and product aging.

The digital-control section consists of a programmable sequencer, a double 8-word buffer, limit alarms, a 16-bit counter, and a μP interface. The ML2200 can easily handle certain tasks that are normally handled by the μP, so it can offload the μP of much of the overhead associated with data acquisition.

In a conventional A/D system, the μP has to set the multiplexer, set the gain, start the conversion, and read the result for each channel. When the alarm channel is acquired, the value must be compared to a maximum value. If the maximum has been exceeded, the μP must execute the shutdown procedure.

In a similar system that uses an ML2200, however, the μP only needs to initialize the ML2200 and read the acquired data from the data buffer. If the alarm channel exceeds the preset limit, an interrupt can be generated, so the μP can handle the alarm condition quickly. The reduction in μP overhead is considerable, and the system using the ML2200 responds to the alarm condition much more quickly than would a system using the conventional approach. The ML2200 costs $60 (1000).

Micro Linear, 2092 Concourse Dr, San Jose, CA 95131. Phone (408) 262-2095. TLX 275906.

Circle No 614

Switching-regulator IC offers three methods of current-mode control

You can connect the CS-320/321 current-mode control ICs in any of three configurations that sense peak inductor current. The CS-320 has an output stage that is active high, and the CS-321 has an output stage that is active low. They provide hysteretic and constant-off time control, as well as the less-precise constant-frequency control.

Current-mode control provides inherent pulse-by-pulse current limiting, which effectively eliminates the 90° phase lag associated with the filter inductor or energy-storage inductor.

You can operate the CS-320/321 ICs at frequencies as high as 1 MHz. They provide a selectable UVLO (undervoltage-lockout) function that is optimized for either off-line bootstrap operation or low-voltage dc inputs; the selectable start/stop thresholds are 14.5V/10.5V and 9.0V/7.8V, respectively. The ICs prevent runaway current conditions during overload by continuously extending the off time. Their high-current totem-pole output stages allows them to drive power MOSFETs, and you can use their high-gain current-sense amplifiers to interface with current-sensing MOSFETs in which a few of the internal cells are brought out to a pin.

The ICs also feature a 5V bandgap reference that's trimmed to either 1% (industrial grades) or 2% (commercial grades); a precision timer circuit that lets you select maximum on/off times for any of the three modes of operation; and a synchronization capability, which lets you connect two or more controllers in parallel.

In 16-pin plastic DIPs, the CS-320/321 ICs cost $3.47 (100) and $2.87 (1000). Samples and small quantities are available from stock to 30 days. Production quantities will be available in September or October.

Cherry Semiconductor Corp, 2000 S County Trail, East Greenwich, RI 02818. Phone (401) 885-3600. TLX 6817157.

Circle No 629

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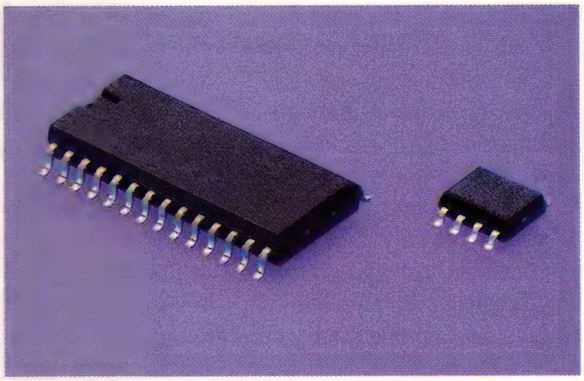
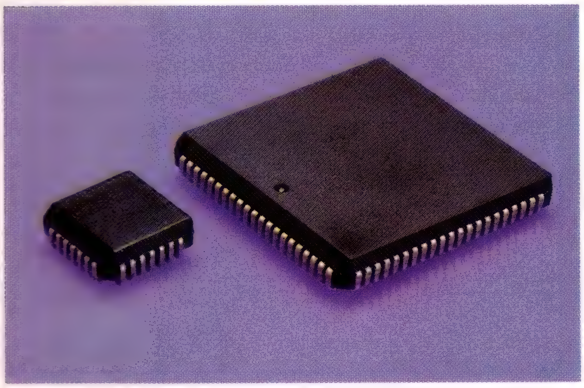
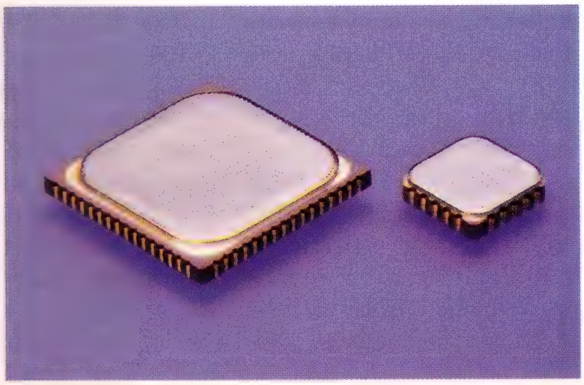






Call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, 0276-685911; Milano, (02) 826-6747.

GE RCA

Servo chip set includes analog and digital circuits

Using the SSI 567 servo demodulator, the SSI 568 servo controller, and the SSI 569 servo motor driver, you add only a controlling μP and a handful of passive components to form a complete disk-drive servo system.

The chip set handles Winchester-disk designs that pack a maximum of 1500 tpi and operate with less than a 20-msec average seek time. Current Winchester systems spec 1200-tpi densities, and many drives only offer densities in the 500- to 800-tpi range. During the past year, drives with seek times of less than 20 msec have emerged. Though the 567/568/569 chip set is intended for such applications, it also economically serves in drives having 20- to 50-msec seek times.

The bipolar servo demodulator chip accepts an industry-standard dibit quadrature pattern from a disk read/write head. The chip only works in a Winchester disk drive with a dedicated servo surface. Circuitry on the chip supports automatic gain control (AGC), area detection to ensure noise immunity, and automatic zero offset. The demodulator delivers N and Q (normal and quadrature) servo signals.

The SSI 568 CMOS servo controller, accepts the N and Q servo signals. The IC supports both track-follow and seek modes, and it handles a speed of 500k servo frames/sec. The controller will accept standard N and Q signals from any demodulator.

The 568 controller IC delivers an error voltage to the SSI 569 bipolar servo-motor controller chip. SSI 569 features include a linear Class B track mode, overcurrent and overvelocity protection, and enable/disable control. The IC will drive a power-MOSFET H-bridge circuit for controlling the current through a linear or rotary voice-coil motor.

The 3-chip set costs less than $35 (10,000). The SSI 567, 568, and 569 come in 28-, 44-, and 20-pin packages, respectively.

Silicon Systems Inc, 14351 Myford Rd, Tustin, CA 92680. Phone (714) 731-7110.

Circle No 610

CMOS dynamic-RAM controller ICs drive 256k- to 4M-bit chips

The controller/driver family consists of the DP8420V, the DP8421V, and the DP8422V, which support 256k-, 1M-, and 4M-bit dynamic RAMs, respectively. The three chips directly address and drive dynamic-RAM arrays as large as 4M bytes, 16M bytes, and 64M bytes, respectively. The DP8420V and DP8421V control single-port dynamic RAMs, and the DP8422V can handle single- or dual-port devices.

The products provide a single-chip interface between μPs and dynamic RAMs. Because they're programmable, the controllers allow you to alter their control-logic configuration. Furthermore, you can interface the ICs directly to any μP in the 32000, 68000, 8086, Z8000, 32100, and Clipper families.

You can also program the memory-access mode of the dynamic-RAM controllers. For example, the chips support burst/nibble, page, and static-column memory-access modes. All of these modes serve to reduce a memory system's effective access time.

The programmable row-address-hold and column-address-setup times allow you to use the controller family with dynamic RAMs independently of the RAMs' specified access times. You can also program the chips' RAS-low time during refresh, the refresh time, the RAS-precharge time, and the RAS/CAS configuration. The controllers automatically perform either staggered or burst refresh.

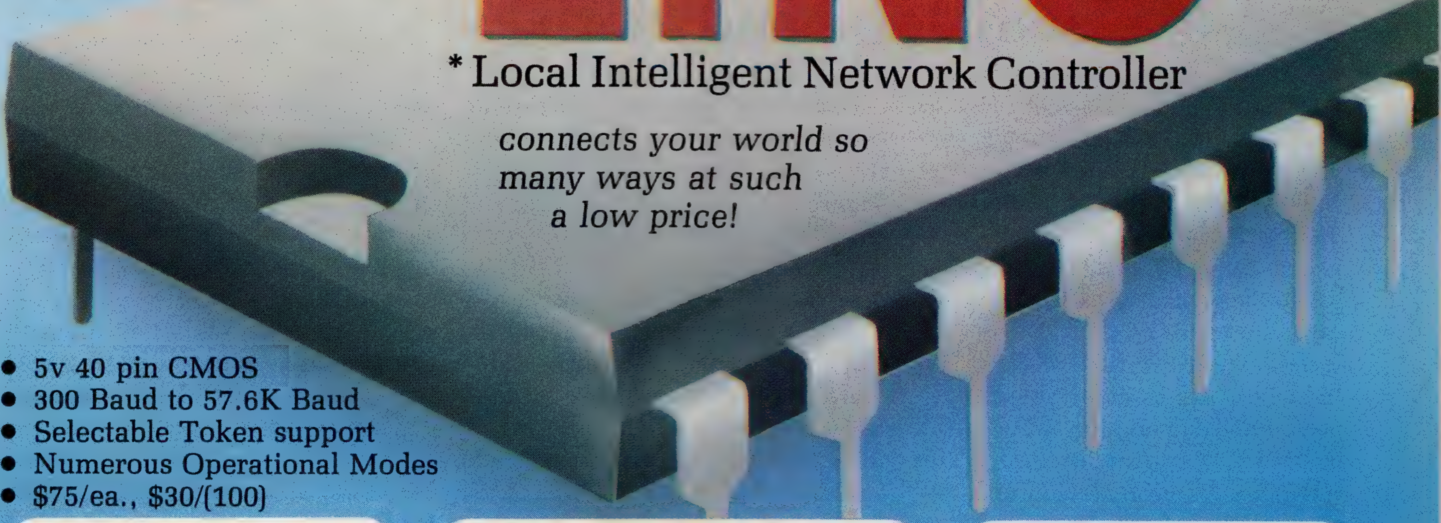
The controllers provide zero-wait-state operation at frequencies of 10 MHz and above. They also include programmable wait-state logic, which automatically inserts wait states into a CPU cycle.

The DP8422V comes in an 84-pin plastic chip carrier; the DP8421V and -20V come in 68-pin plastic chip carriers. DP8422V, $25; DP8421V, $20; and DP8420V, $17 (1000).

National Semiconductor Corp, 2900 Semiconductor Dr, Santa Clara, CA 95052. Phone (408) 721-5000.

Circle No 608

The CY233-LINC*



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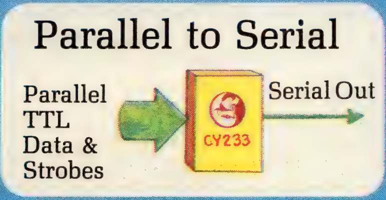
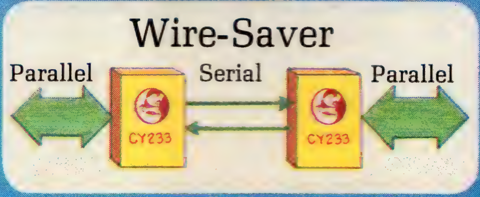
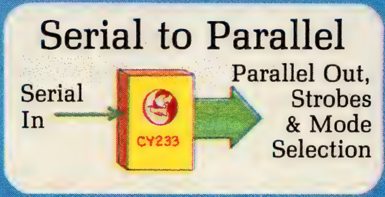

Parallel to Serial


Wire-Saver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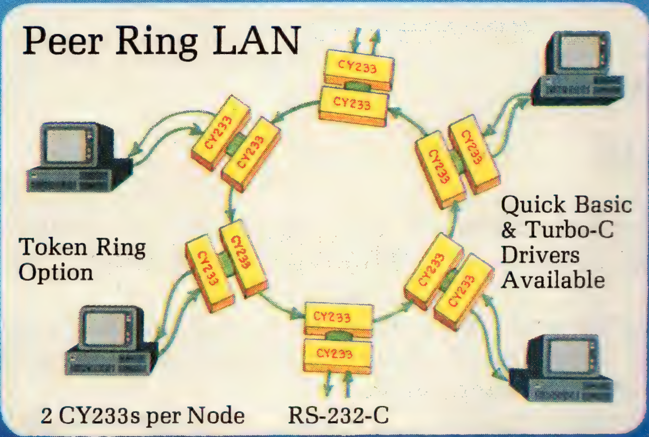
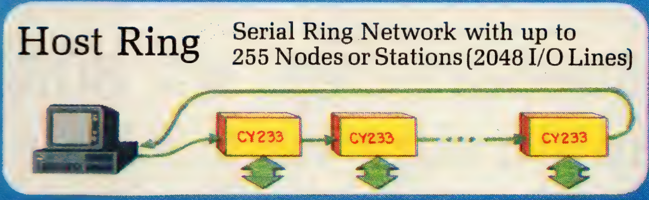
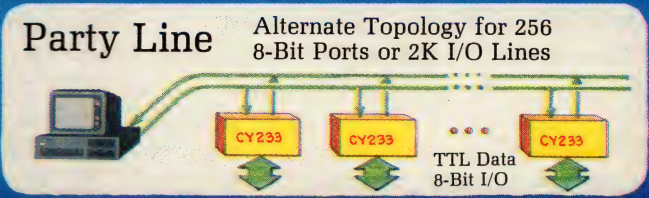
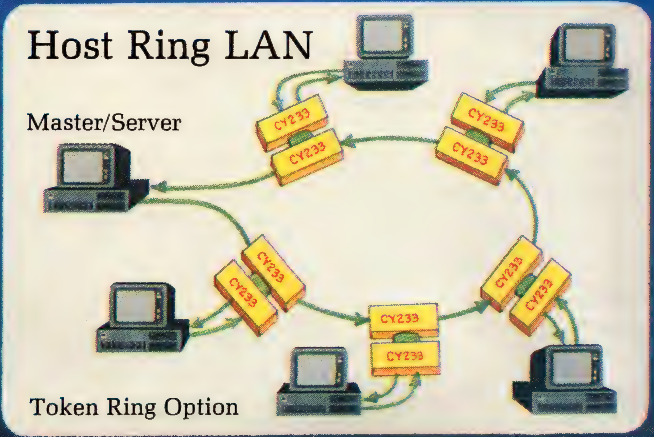

Peer Ring LAN


Host Ring

Serial Ring Network with up to 255 Nodes or Stations (2048 I/O Lines)


Party Line

Alternate Topology for 256 8-Bit Ports or 2K I/O Lines


Host Ring LAN

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EDN 070987

CIRCLE NO 82

Flash A/D converter features 115-MHz analog bandwidth

Fabricated in a high-density bipolar process, the AD9002 flash A/D converter features a sampling rate of 150M samples/sec and a 3-dB analog bandwidth of 115 MHz. The converter has a 750-mW typical power dissipation and a 17-pF analog input capacitance.

You can use the AD9002's external hysteresis-control pin in high-noise environments to optimize the comparator's sensitivity. The AD9002 also incorporates an overflow bit that signals over-range inputs. You can disable the overflow output by means of the overflow-inhibit pin.

Other key specifications for the converter include a signal-to-noise ratio of 43 dB at 1 MHz, harmonic suppression of 63 dB at 1 MHz and 50 dB at 40 MHz, and maximum differential linearity of 0.5 LSB. To operate, the AD9002 needs only a voltage reference, an encode signal, and a single −5.2V supply.

The AD9002 is available with 0.5 LSB or 0.75 LSB linearity. Both of these parts come in industrial-grade (−25 to +85°C) and MIL-STD-883 Rev C (−55 to +125°C) versions. The industrial-grade parts come in 28-pin ceramic DIPs. The military grades are available in 28-pin ceramic DIPs or leadless chip carriers.

Unit pricing for the industrial-grade parts is $90 for the 0.75-LSB version and $135 for the 0.5-LSB version. The MIL-STD-883 parts are priced at $270 and $360 for the 0.75-LSB and 0.5-LSB versions, respectively. The industrial grades are available now; the MIL-STD-883 grades are scheduled for delivery in August.

Analog Devices, One Technology Way, Norwood, MA 02062. Phone (617) 329-4700. TWX 710-394-6577.

Circle No 626

Support chips for 80386 µP move data via a 32-bit bus

Because the timing and I/O specs of the 80387, 82385, and 82380 support chips match the requirements of the 80386 µP, the four chips together form an optimized 32-bit computer.

The 80387 accelerates floating-point calculations; the 82385 controls cache-memory functions. The 82380 Integrated System Peripheral combines DMA control with system-support functions.

In addition to its DMA controller, the 82380 includes a 20-level programmable interrupt controller, four 16-bit programmable interval timers, a programmable wait-state generator, dynamic RAM, a refresh controller, and system-reset control logic.

The 82385 cache-controller allows you to update main memory after each write cycle, thereby maintaining the concurrency of the cache and main memory.

The 80387 runs floating-point calculations four to six times faster than does the company's earlier 80287. The chip's instruction set is compatible with those of the 8087 and 80287 coprocessors.

A 20-MHz 80386, which allows you to take full advantage of the support chips, is available now. The manufacturer plans to ship the 20-MHz versions of the 80387 and the 82380 in the second half of 1988; the 16-MHz models are available now. Shipments of the 16-MHz 82385 will begin before the end of 1987; the vendor will announce the price at that time.

The 20-MHz 80386 costs $599; the 16-MHz 80387, $500. The 16-MHz 82380 costs $149; the 20-MHz version, $299 (100).

Intel Corp, Box 58065, Santa Clara, CA 95052. Phone (408) 987-5730.

Circle No 619

THE SOUTH POLE IS TOUGH ON MICROCOMPUTERS

Dr. J.P. Oliver, SPOT, Mr. J.D. McNeill and, marked by flags in the background, the South Pole.

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Dynatem microcomputer modules really prove themselves in the toughest applications. The all-CMOS VME modules are terrific for multi-processor advanced applications. The wide family of RM 65 compatible modules based on the 68000 SBC can solve almost any single processor application easily and efficiently. With all that, they're suprisingly low priced. Call or write today for more information.

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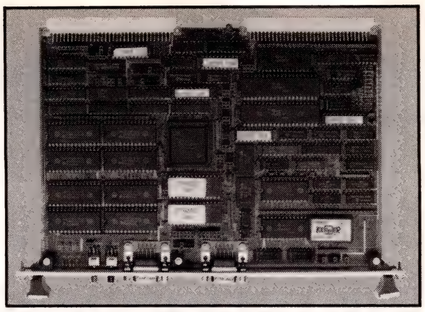
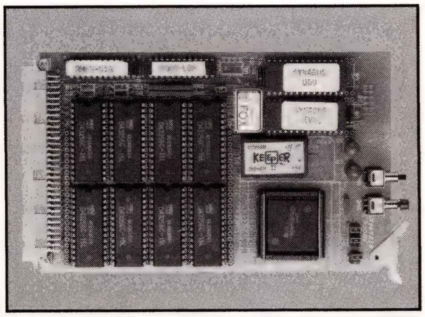
CIRCLE NO 78



All CMOS VME SBC is I/O Oriented, PC Programmable

DCPU1 is the first all CMOS SBC on the VMEbus, with low power and low heat dissipation. Based on a 12.5 MHz 68HC000 CPU (68010 optional), it offers two serial ports, 40 programmable parallel lines, plus three 16-bit timers with watchdog capabilities and a real-time clock/calendar. Up to 512 Kbytes of no-wait, dual ported, static RAM, 128 Kbytes of PROM. Programs can be prepared on an IBM or compatible PC and down loaded. Functions as master or slave, receives and generates 7 levels of interrupt. Under $1000. **Dynatem Inc.**, Irvine, CA.

CIRCLE NO 117



68000 Based SBC Supports RM 65 Module Family

The RM65-68000 is a 68000/68010 based SBC on the single-Eurocard RM 65 bus, which is backed by a full family of modules to match almost any application efficiently and is supported by interchangeable software. It is all CMOS, with up to 512 Kbytes of battery-backed RAM on board and up to 256 Kbytes of EPROM. It has an asynch serial interface with programmable baud rate and watchdog circuitry. Programs can be developed on an IBM or compatible PC and downloaded. Under $500. **Dynatem Inc.**, Irvine, CA.

CIRCLE NO 156

MPU and FPU combine to provide twice the performance of a VAX 8600

The MC68030 MPU and MC68881 floating-point coprocessor chip, when integrated into an engineering workstation, can provide two to three times the performance of a VAX 8600. You can also use the 68030 as the core processor for a lower-end ($2000 to $3000) office-automation system and still exceed the VAX 8600's performance.

The MC68030 offers twice the performance of the 68020 and is 100% upwardly software compatible with the entire 68000 line of MPUs. The 68030 incorporates a 68020 core, which is enhanced by increased parallelism, dual on-chip caches (one for data and one for instructions), dual internal data- and address-buses (two 32-bit data and two 32-bit address), and an on-chip paged memory-management unit. The on-chip caches are each 256 bytes deep.

The MC68882 enhanced floating-point coprocessor offers two to four times the performance of its antecedent part, the MC68881. The two parts are compatible in both instruction set and physical attributes; you can plug a 68882 into the socket occupied by a 68881 and immediately realize a 50% improvement in performance. If you choose to optimize your software for the 68882, you can get a two- to fourfold improvement in performance.

The 68882 conforms to the IEEE 754 standard for binary floating-point arithmetic, including all requirements and suggestions. The chip offers the four basic math functions as well as a full selection of transcendental and nontranscendental functions, such as root values, trigonometric functions, exponentials, hyperbolic functions, and logarithms. The 16.67-MHz versions of the chips will be available this quarter. MC68030, $325; MC68882, $200 (100).

Motorola Inc, 6501 William Cannon Dr W, Austin, TX 78735. Phone (512) 440-2000.

Circle No 630

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CIRCLE NO 11

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64 bit

CY7C189
16x4 15ns 90mA
CY7C190
16x4 15ns 90mA
CY27LSO3M
16x4 65ns 38mA

CY7C122
256x4 15ns 90mA
CY7C123*
256x4 7ns 120mA
CY93422
256x4 45ns 120mA
CY93L422
256x4 60ns 80mA

CY7C147
4Kx1 25ns 90/15mA
CY7C148
1Kx4 25ns 90/15mA
CY7C149
1Kx4 25ns 90mA
CY7C150
1Kx4 15ns 90mA

CY7C130*
dual port
1Kx8 35ns 120/30mA
CY7C140*
dual port
1Kx8 35ns 120/30mA

CY7C128
2Kx8 25ns 120/20mA 300 mil
CY6116
2Kx8 35ns 130/20mA
CY7C132*
dual port
2Kx8 35ns 120/30mA
CY7C142*
dual port
2Kx8 35ns 120/30mA
CY7C167
16Kx1 25ns 45/60mA
CY7C168
4Kx4 25ns 70/90mA
CY7C169
4Kx4 25ns 70/90mA
CY7C170
4Kx4 25ns 90mA
CY7C171
4Kx4 25ns 70/90mA
CY7C172
4Kx4 25ns 70/90mA

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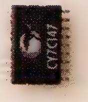
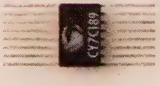
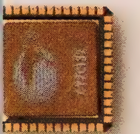
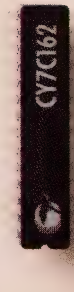


need.







64K

CY7C185
8Kx8 35ns 100/20mA 300 mil
CY7C186
8Kx8 35ns 100/20mA
CY7C161
16Kx4 25ns 70/20mA
CY7C162
16Kx4 25ns 70/20mA
CY7C164
16Kx4 25ns 70/20mA
CY7C166
16Kx4 25ns 70/20mA
CY7C187
64Kx1 25ns 70/20mA

CMOS SRAM

If your job is building faster systems, here are a few compelling reasons to think Cypress Semiconductor when you think fast SRAM.

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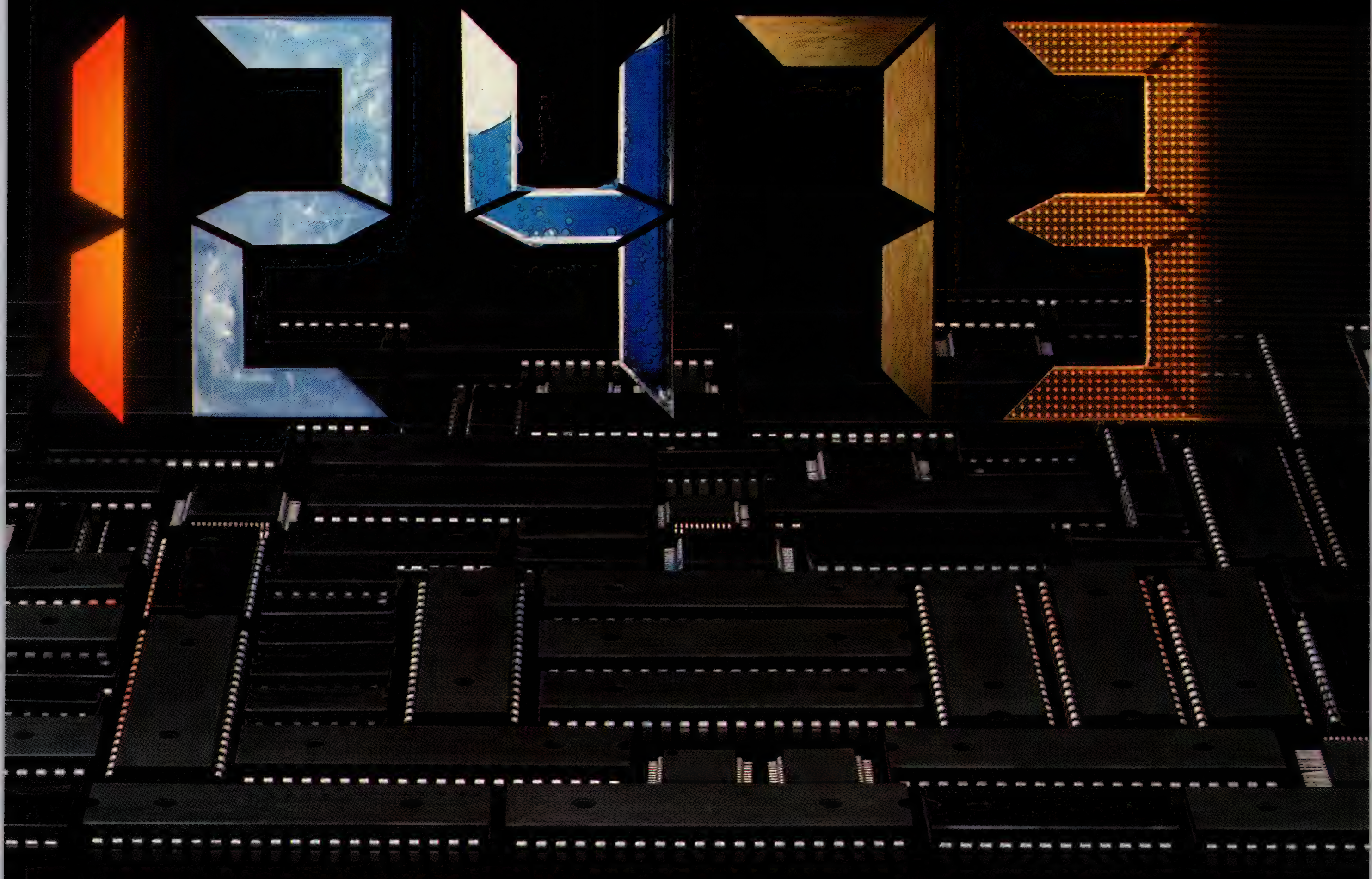
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TSC **7107**	LED drive, 3 1/2 digit.
TSC **7116**	LCD drive, 3 1/2 digit with display hold.
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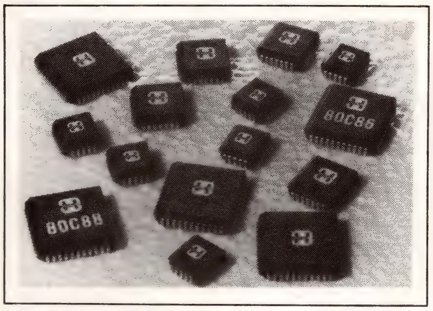
TSC **826**	40 LCD segment output LCD. ADC also.
TSC **827**	101 LCD segment output ADC with high & low setpoints, serial data output. **New!**

CIRCLE NO 174

Integrated Circuits



CMOS μP FAMILY

This family of 13 CMOS peripheral and bus-support devices complements the manufacturer's 80C86 and 80C88 μPs. Housed in PLCCs, the ICs are available in both commercial (0 to 70°C) and industrial (−40 to +85°C) versions. The family comprises a DMA controller, a serial datacomm IC, a programmable UART, a timer/counter, a parallel-I/O device, an interrupt controller, two octal latching bus drivers, a clock generator, a static clock controller, two data-bus transceivers, and a bus controller. Prices for the commercial-grade parts range from $6.44 to $33.45; for the industrial-grade devices, from $9.82 to $34.78 (100).

Harris Corp, Semiconductor Sector, Box 883, Melbourne, FL 32901. Phone local office.

Circle No 411

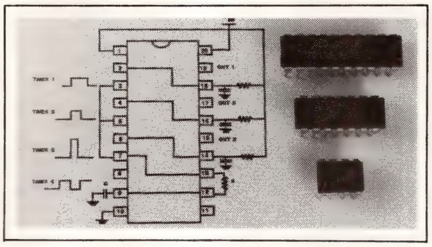
MICROCONTROLLER

The Model M50747ES microcontroller contains 8k bytes of EPROM. The μC is available in a version that uses a glass-windowed ceramic DIP or in a one-time-programmable version in a plastic DIP. Both DIPs have 64 pins. You can also obtain the μC in a 72-pin quad flat pack.

You can operate the devices in any of four modes: microprocessor, memory-expansion, single-chip, or evaluation. The IC has 256 bytes of RAM, an on-chip UART, three 8-bit timers, two prescalers, and 56 I/O lines. Its development tools include software that runs in MS-DOS and CP/M systems, and in-circuit emulator boards and debugging units. $45.50; one-time-programmable version, $20.25 (100).

Mitsubishi Electronics America Inc, 1050 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 730-5900.

Circle No 409



QUAD CMOS TIMERS

Able to trigger from 50-nsec pulses, this family of CMOS timers embraces two sets of single, dual, and quad devices. All units spec rise and fall times of 10 nsec. The single, dual, and quad models ALD1502, -2502, and -4501 operate from 2 to 12V supplies; models ALD1504, -2504, and -4503 can use 1 to 12V supplies. The quiescent-current specs range from 70 μA max for a single device operating from a 1V supply, to 270 μA at 5V for the quad units.

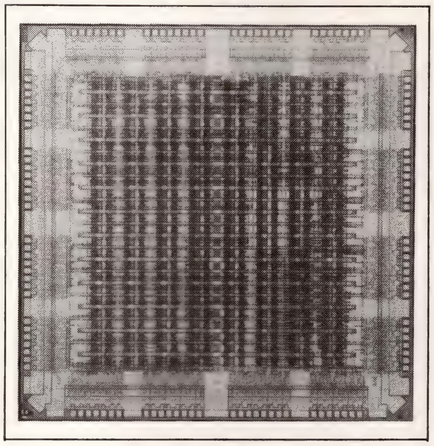
The single and dual devices' current-sinking capability is 80 mA; the quad devices can sink 40 mA. The singles and duals are pin compatible with NE555 and NE556 bipolar units; the quads have a 20-pin configuration that allows for four independent timing thresholds. The single, dual, and quad timers are available in 8-, 14- and 20-pin (respectively) plastic and ceramic DIPs. $0.81 to $3.41 (100).

Advanced Linear Devices Inc, 1030 W Maude Ave, Suite 501, Sunnyvale, CA 94086. Phone (408) 720-8737. TWX 510-100-6588.

Circle No 412

ECL GATE ARRAYS

The first two products in the manufacturer's planned ECL-gate-array family, Models ET3000 and ET4500, offer equivalent gate densities of 4580 and 6580 gates, respectively.



The basic gate used in both parts has propagation times of 220 psec (unloaded) and 500 psec (loaded). I/O propagation delays are 650 psec for each ECL output buffer and 5 nsec for each TTL I/O-buffer pair.

Model ET3000 can have as many as 120 I/O lines, of which you can configure 72 as ECL output buffers; the ET4500 has 136 I/O lines, of which you can use 84 as ECL outputs. You can use either part as TTL gate arrays that operate from 5V, or as 10KH or 100K ECL arrays that work from −5.2 and −4.5V, respectively. For mixed TTL/ECL applications, the devices can operate from 5V and −4.5 or −5.2V. The ET3000 and ET4500 come in a 149-pin ceramic pin-grid array (PGA) containing a heat sink; the ET4500 is also available in a 208-pin PGA. The devices dissipate 6 to 7W and 9 to 10W, respectively. ET3000, $228; ET4500 (in 149-pin PGA), $335 (100).

Fujitsu Microelectronics Inc, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-1700. TWX 910-338-0190.

Circle No 410

GaAs AMPLIFIER

A member of the manufacturer's family of 1500 Series GaAs fiber-optic devices, the TIA1500 transimpedance amplifier is a monolithic IC that's suitable for use in analog or digital fiber-optic systems. It accepts input frequencies as high as 2 GHz from either a pin diode or an

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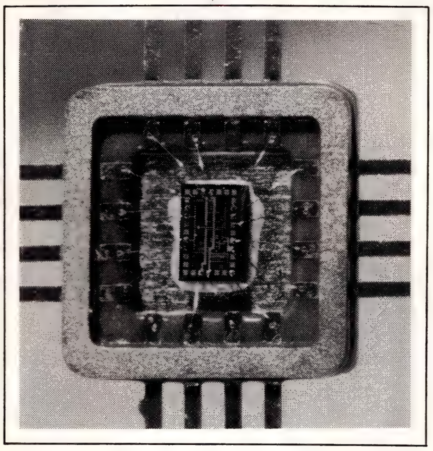
CIRCLE NO 176

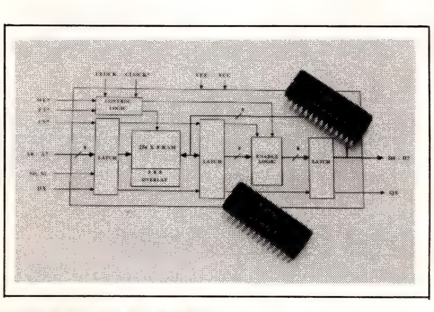


avalanche photodiode. An adjustable FET feedback network allows you to optimize the IC's receiver sensitivity and transimpedance gain in your application.

The device draws 120 and 110 mA, respectively, from its 4 and −3.5V supplies. Its 500-MHz transimpedance is 1 kΩ; the maximum input power is 0 dBm; its sensitivity at 1 GHz is −30 dBm; and the automatic-gain-control range is 10 dB. The amplifier is available in chip form or in a 46×72-mil ceramic package. $150.

Microwave Semiconductor Corp, 100 School House Rd, Somerset, NJ 08873. Phone (201) 563-6300. TLX 833473.

Circle No 413

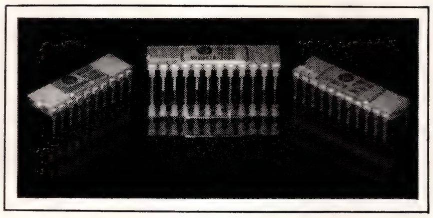


STATIC RAMs

These four pipelined static RAMs find use as color-palette memories in graphics systems having resolution as high as 2000×2000 pixels. Models Bt401, -402, -403, and -404 are all 256×8-bit static RAMs that spec 4-nsec cycle times. You can cascade any of the RAMs to build large color palettes. Each chip has 3-state outputs. Models Bt401 and -402 have 3×8-bit Sidecar RAMs that provide cursor support and overlay capabilities. The Bt401 is compatible with 10K ECL circuitry and the Bt402 works with 100K ECL circuitry. Models Bt403 and -404 are equivalent to the Bt401 and -402, respectively, but do not contain the 3×8-bit Sidecar RAMs. All the RAMs accommodate synchronous and asynchronous reading and asynchronous writing. Housed in 28-pin ceramic DIPs, Models Bt401 and -402 cost $39 (100). In 24-pin ceramic DIPs, Models Bt403 and -404 cost $36.

Brooktree Corp, 9950 Barnes Canyon Rd, San Diego, CA 92121. Phone (619) 452-7580. TLX 383596.

Circle No 414

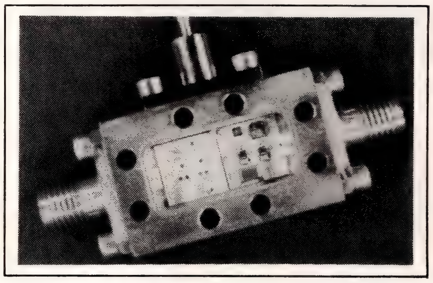


STATIC RAMs

These six CMOS-processed, 16k-bit static RAMs spec access and cycle times as low as 20 nsec. Models VT20C18 and VT20C19 are organized as 2048×8 bits; Models VT20C68/69/78/79 are organized as 4096×4 bits. In addition to their 20-nsec access and cycle times, Models VT20C19/69/79 have a fast-chip-enable option that provides data access in as little as 10 nsec. Models VT20C18/19/78/79 also have a fast-output-enable control function. The active power consumption is typically 550 mW. Models VT20C18/68/78 reduce power consumption further by providing an automatic power-down feature that reduces standby power consumption to 35 mW in the presence of TTL inputs. For CMOS inputs, the standby current consumption is 10 nA max. Models VT20C18/19 come in 24-pin, side-brazed ceramic DIPs; the VT20C68/69, in 20-pin, side-brazed DIPs; and the VT20C78/79 in 22-pin, side-brazed DIPs. The 20-nsec versions of the VT20C18/19, $21.24; of the VT20C68/69/78/79, $14.28 (1000).

VLSI Technology Inc, 1109 McKay Dr, San Jose, CA 95131. Phone (408) 434-3000. TLX 278807.

Circle No 415



GaAs MMICs

Housed in the manufacturer's miniature, removable-connector package (PMpac), this series of GaAsFET monolithic microwave amplifiers (MMICs) operates over the 2- to 6-GHz range. The family comprises low-noise, small-signal, and medium-power devices. Amplifiers having gain as high as 30 dB are available in the 1-in.-long housing.

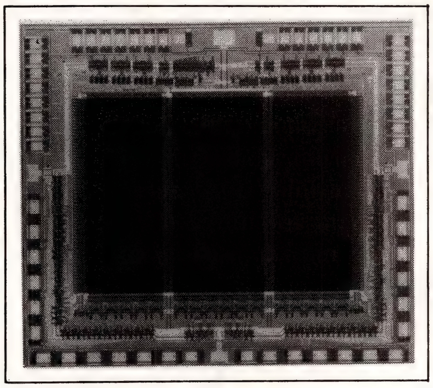
The low-noise series offers a 3.2-dB noise figure, a 10-dBm output power, and gain levels to 28 dB. For example, Model PM-CAM0601 has a 16-dB gain, a 3.2-dB noise figure, and a 10-dBm power output; the device draws 80 mA. The small-signal Model PM-CAM0615 specs a 24-dB gain, an 8.5-dB noise figure, and a 10-dBm power output, and it draws 110 mA. The medium-power units have power outputs to 18 dBm, gains of 16 to 31 dB, and noise figures as low as 3.5 dB. $700 to $1000.

Pacific Monolithics, 245 Santa Ana Ct, Sunnyvale, CA 94086. Phone (408) 732-8000.

Circle No 416

DUAL-PORT RAM

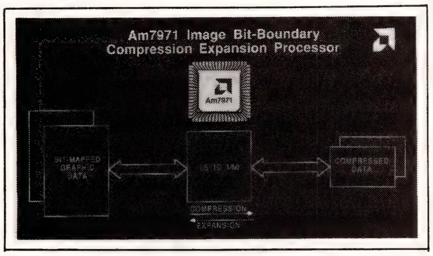
The Model VT16AM8 dual-port RAM, intended for applications using a multiplexed address/data bus, can transfer data between systems having dissimilar word sizes.



Like its earlier sibling, Model VT16DP8, the device's left port is organized as 1024 16-bit words and its right port is organized as 2048 8-bit words. The 16-bit port has a full address and data I/O field; you can configure the port to read and write in either word or byte mode. The 8-bit port multiplexes the eight low-order addresses with the eight data-I/O signals. The data access time is 60 nsec. The RAM incorporates all the interface logic required by 8- and 16-bit systems; it also contains contention-arbitration logic, an interrupt function, and automatic power-down for each port. In a 52-pin PLCC, $55.10 (1000).

VLSI Technology Inc, 1109 McKay Dr, San Jose, CA 95131. Phone (408) 434-3000. TLX 278807.

Circle No 417



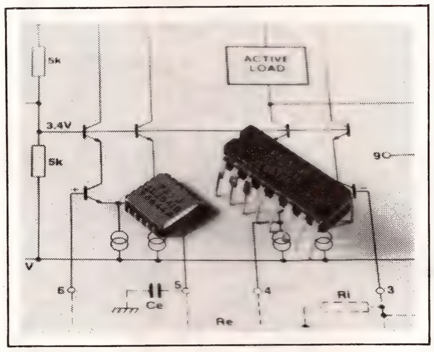
COMPANDER IC

This 1-chip compression/expansion processor allows you to process documents for transmission to the nearest bit or pixel. Model Am7971 is an intelligent processor that achieves typical compression ratios of 30:1. It contains two programmable registers for bit-boundary control. The device compresses and expands 2-tone, bit-mapped documents in accordance with CCITT recommendations T.4 and T.6 for Groups III and IV facsimile equipment. Its coding options are 1-dimensional modified-Huffman run-length coding, and 2-dimensional modified-Read relative coding.

The chip can operate in line-by-line, fractional, and full-page modes. Equipped with an on-chip error-detection mechanism, the device detects all possible data corruptions by checking for illegal codes, negative run lengths, and incorrect line lengths. The IC operates at 5 MHz. Prices for devices in 68-lead PLCCs and LCCs are $119.05 and $142.86 (100), respectively.

Advanced Micro Devices Inc, Box 3453, Sunnyvale, CA 94088. Phone (408) 982-7445.

Circle No 363



OP AMP

Featuring output rising- and falling-edge slew rates of 1400 and 900 V/μsec respectively, the SL2541 op amp can directly drive 50Ω loads with a bandwidth greater than 800 MHz. The op amp's gain-bandwidth product is typically 2.5 GHz, and various parameters (including open-loop gain, output current, supply voltage range, and output dc offset) are externally programmable. The output settles to 0.5% of final value in 30 nsec and to 0.1% in 40 nsec. Using ±15V supplies, the input is capable of handling 20V p-p signals, and the output can produce 12V p-p outputs at a maximum current of ±15 mA. The output's full-power bandwidth is 40 MHz.

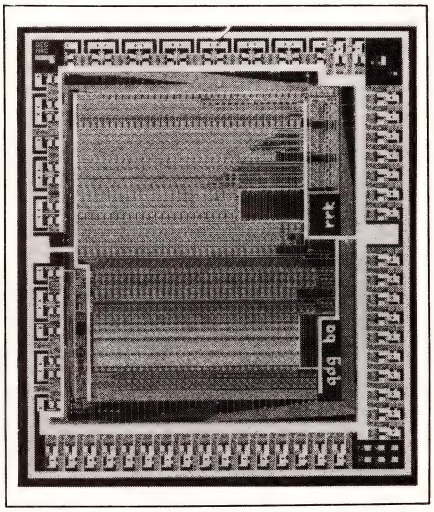
The SL2541 is supplied in a 16-pin ceramic DIP or 20-pin leadless chip carrier, both of which can operate over the military temperature range. It is also available as a professional-grade (−30 to +85 °C) device. From £23.66 (1000) for the DIP professional-grade part to £32.80 (1000) for a military-grade part screened to MIL-STD-883C requirements.

Plessey Semiconductors Ltd, Cheney Manor, Swindon, Wiltshire SN2 2QW, UK. Phone (0793) 36251. TLX 449637.

Circle No 364

Plessey Semiconductors, 9 Parker, Irvine, CA 92718. Phone (714) 472-0303. TLX 701464.

Circle No 365



MAC IC

The MA7010 is a 16×16 multiplier/accumulator IC that is pin- and function-compatible with IDT7210 and TDC1010 parts. In addition, the 68-pin version offers an internal pipeline register and an accumulator output register that you can reset to zero. These additional facilities suit the part to digital filtering and matrix evaluation applications.

Activating the pipeline register introduces one clock-cycle latency into the multiply/accumulate process, but allows you to reduce the device's cycle time to 55 nsec. When the pipeline register is inactivated, the device has an 85-nsec multiply/accumulate time. The device accepts a 16-bit 2's complement or unsigned

Text continued on pg 148

To EDN readers, for consistently votin
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magnitude inputs, and produces a 35-bit result that you can optionally round up to 19 bits. You can select the multiplier/accumulator to perform accumulation or subtraction, and you can preload it with a 35-bit value. The MA7010 is fabricated in CMOS SOS (silicon on saphire) and is available in a 64-pin DIL package, or in a 68-pin leadless chip carrier or pin-grid array. Approximately £60 (100).

Marconi Electronic Devices Ltd, Doddington Road, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

Circle No 366

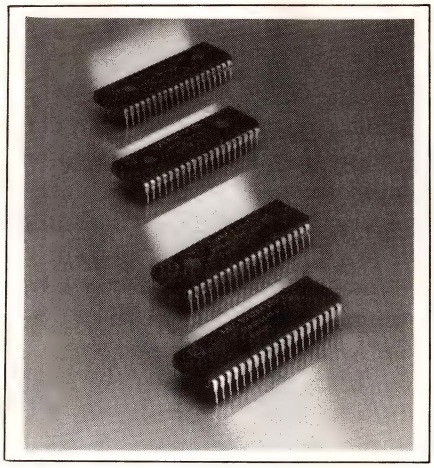
Marconi Electronic Devices Inc, 45 Davids Dr, Hauppauge, NY 11788. Phone (516) 231-7710. TLX 275801.

Circle No 367

MICROCONTROLLERS

Pin-compatible with the equivalent Intel types, the MAB8032AH and MAB8052AH are enhanced versions of the 8051 microcontroller. The MAB8052AH provides 8k bytes of mask-programmable ROM, 256 bytes of RAM, and the capability to address as much as 128k bytes of external memory. The MAB8032AH is a ROMless version of the MAB8052AH. Both devices provide four 8-bit I/O ports, a 6-source nested-interrupt structure with two priority levels, three 16-bit timers, and a full-duplex serial I/O port. Their architecture provides nonpaged jumps, direct addressing, four 8-bit register banks, and stacks as deep as 256 bytes.

Instructions are included for BCD and binary arithmetic, and bit-handling functions. The microcontrollers feature a 12-MHz on-chip oscillator, or alternatively accept external clock frequencies in the 3.5- to 12-MHz range. The company can also supply the MAB8031AH, a ROMless version of the MAB8051AH, with a 15-MHz on-chip oscillator. All these microcontrollers are available for operation within three ranges: 0 to +70°C, −40 to +85°C, and −40 to +100°C. MAB8032AH, DM 8; MAB8052AH, DM 10; 15-MHz MAB8031AH, DM 8.60 (50,000).



Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 372

DMA CONTROLLER

The SAB82257 16-bit DMA controller provides an interface directly to 80286, 80186/188, and 8086/88 µPs. It also has a remote mode that allows you to use it with other processors. The controller has four independent DMA channels that are capable of data-transfer speeds as high as 8M bytes/sec with an 8-MHz clock in 80286 systems, or 4M bytes/sec with an 8-MHz clock in 8086/186 systems. It supports 16M-byte memory and I/O address spaces and can transfer a maximum block size of 16M bytes. You can chain-command blocks for any channel so that they are executed sequentially, and you can include conditional and unconditional stop and jump commands to create complex DMA sequences.

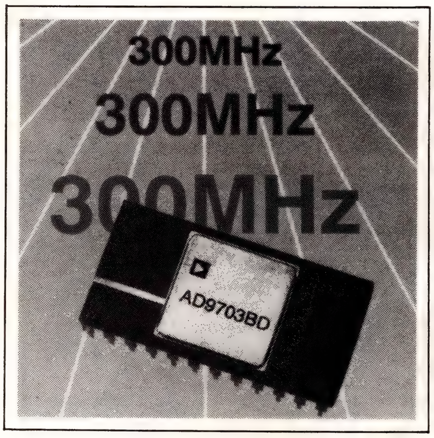
Using data chaining, you can build a destination data block from multiple source data blocks or break up one source block into multiple destination blocks. When physical and logical bus widths differ, the DMA controller automatically assembles/disassembles bytes into words, or words into bytes as necessary. It also performs byte/word transformations where source and destination logical bus widths differ. The device comes in a 68-pin plastic leaded chip carrier. DM 35 to DM 50 in low volumes.

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 370

Siemens Components Inc, 186 Wood Ave S, Iselin, NJ 08803. Phone (201) 321-4842.

Circle No 371



VIDEO D/A CONVERTER

Offering 300-MHz word rates and a low (45-pV·sec) glitch impulse, the Model AD9703 8-bit video D/A converter is suitable for displays having resolutions as high as 2k×2k pixels. The device incorporates blanking, composite-sync, 10% overbright, and reference-white control pins. The settling time to within ±0.4% of full gray-scale output is 6 nsec. Other specs include ±0.2% max integral and differential nonlinearity, ±2-mV max initial offset voltage, and guaranteed monotonicity.

The converter's logic inputs are compatible with both 10KH and 100KH ECL systems; the output satisfies the RS-170 video standard and can drive a 75Ω line directly. The AD9703 comes in a 24-pin DIP, operates from a −5.2V ECL supply, and dissipates 1.1W. Nonhermetic BW-grade units operate over −25 to +85°C; hermetic BD- and TD-grade units operate over −55 to +125°C. The three grades cost $42.60, $47.20, and $52.90 (100), respectively.

Analog Devices Inc, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 329-4700. TWX 710-394-6577.

Circle No 376

EPROM

The TS27C1024 is a 1M-bit UV-erasable CMOS EPROM organized as 64k×16 bits. The EPROM is available in a range of access times from 120 to 250 nsec and consumes a maximum of 50 mA from its 5V supply. The device has a programming voltage of 12.5V and contains its own electronic signature so that PROM programmers can automatically identify the part. Suitable programmers can program the entire EPROM in around 30 sec.

The TS27C1024 is housed in a 40-pin ceramic DIP or in a 44-pin plastic leaded chip carrier. It will also be available as a one-time-programmable part in a plastic package. The TS27C1024 sells for around $25 (1000), with future pricing remaining in-line with other 1M-bit EPROM manufacturers.

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

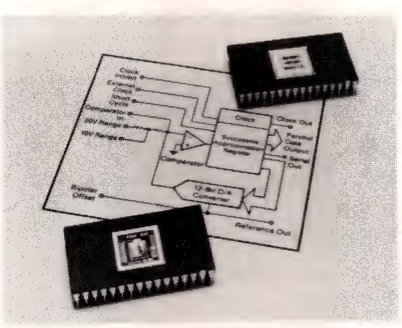
Circle No 368

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, TX 75006. Phone (214) 466-6000. TLX 730643.

Circle No 369

A/D CONVERTER

The ADC80MAH-12 is a monolithic design of the industry-standard ADC80 12-bit A/D converter, and it contains all the circuit blocks required by a successive-approximation ADC. The device's on-chip circuitry includes a comparator, a 6.3V laser-trimmed reference, a successive-approximation register, a clock, and associated logic. The ADC specs a 25-μsec max conversion time and guarantees ±0.012% max nonlinearity and no missing codes over −25 to +85°C.



By making appropriate pin connections, you can choose bipolar input ranges of ±2.5, ±5, or ±10V, or unipolar ranges of 0 to 5 or 10V. Housed in a 32-pin hermetic DIP, the ADC80MAH-12 operates from ±12 to ±15V split supplies and a 5V logic supply. Power dissipation is 705 mW max. $35 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 377

COMM IC

The MK5025 communications controller provides link-level (LAPB) control of the 1984 CCITT version of X.25 communications links that operate at data rates as high as 7M bps. The controller implements frame formatting, FCS generation and checking (16- or 32-bit CRC), transparency (bit-stuffing), error recovery by retransmission, sequence number control, and unnumbered and supervisory frame control. The controller is also compatible with X.32, X.75, and ISDN LAPD link-level protocols. A transparent mode allows you to disable the X.25 processing so that you can implement custom protocols. All interactions between the IC and the network-level software conform to the ISO (International Organization for Standardization) service-primitives concept. A 2-channel on-chip DMA controller manages data transfers to and from host memory, and on-chip 64-byte transmit- and receive-data FIFOs buffer data to and from the network. The MK5025 interfaces to most popular 8- and 16-bit μPs. $47 (1000).

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

Circle No 408

Thomson Components-Mostek Corp, 1310 Electronics Dr, Carrollton, TX 75006. Phone (214) 466-6000. TLX 730643.

Circle No 373

DRIVER IC

The 5-pin L9350 high-side driver IC can deliver as much as 600 mA with a typical output saturation voltage of 0.7V at full rated output current. The driver's control input is TTL compatible. Targeted at automotive applications, the driver operates over a supply-voltage range from 4.5 to 24V and can withstand voltage transients of ±120V, 60V load-dump transients, and battery reversals on its power-supply input. The output stage is protected against short circuits to either supply, and against ±60V transients. An additional safety feature ensures that the output is turned off if the control input or supply ground is disconnected. $1.80 (100,000).

SGS Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

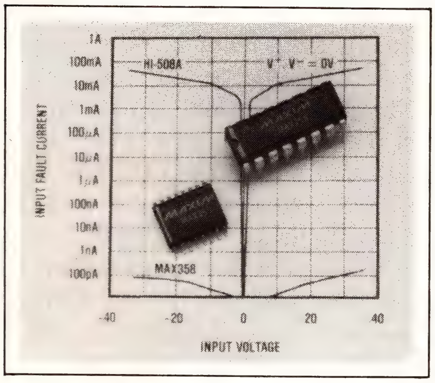
Circle No 374

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 375

MULTIPLEXERS

Models MAX358 (eight channels) and MAX359 (four differential channels) are analog multiplexers that offer improved fault protection com-

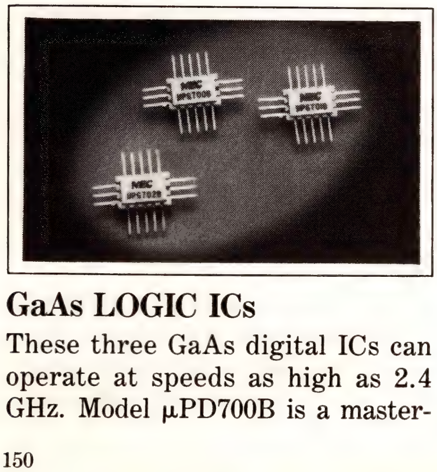


pared with such devices as the HI-508A and HI-509A. Under a power-down fault condition, the units typically allow less than 1 nA/channel of input leakage current in the presence of input voltages as high as ±35V. Furthermore, the multiplexers can withstand continuous ±35V overvoltages on all their inputs simultaneously.

Other characteristics of the MAX358/359 include break-before-make switching and latch-up-proof operation in the power-down condition (even with input signals applied). The devices draw 200 µA from ±4.5 to ±18V supplies. Drain-on and drain-off leakage currents are 5 nA max; source-off leakage is 1 nA max. Both devices are available in 16-pin plastic DIPs, ceramic DIPs, and surface-mount packages. Prices for commercial- and military-temperature-range versions start at $7.35 and $17.35 (100), respectively.

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 378

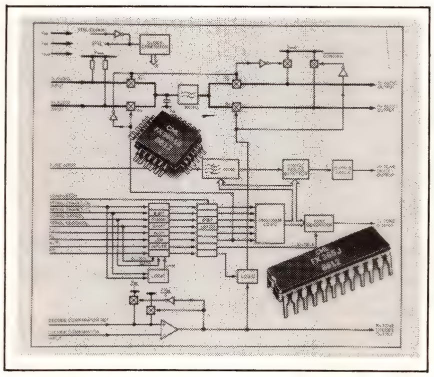


GaAs LOGIC ICs

These three GaAs digital ICs can operate at speeds as high as 2.4 GHz. Model µPD700B is a master-slave D-type flip-flop that has set/reset functions. Model µPD701B is a master-slave T-type flip-flop that also offers set/reset functions. Model µPD702B is a 3-input Or/Nor gate. The typical positive-supply current (I_{DD}) for the µPD700B and -702B is 70 mA; the µPD701B's I_{DD} is 80 mA. Models µPD700B and -702B draw a 50-mA negative-supply current (I_{SS}); the µPD701B draws 60 mA. In 16-pin hermetic ceramic packages, $197 (100). Delivery, three months ARO.

California Eastern Laboratories, 3260 Jay St, Santa Clara, CA 95054. Phone (408) 988-3500.

Circle No 379



ENCODER/DECODER

Targeted for use in radio-communication systems, the FX365 CTCSS (continuous tone controlled squelch system) encoder/decoder features a µP interface that allows you to generate, encode, and decode 38 subaudible tones between 67 and 250 Hz. In addition, the µP interface allows you to switch between transmit and receive modes, and to override the tone-decoding circuitry so that you can monitor a received audio signal. The µP interface operates in parallel or serial mode. In the parallel mode, a latch-enable input loads control data into an internal latch; in the serial mode, you can load control data via a serial port and clock inputs.

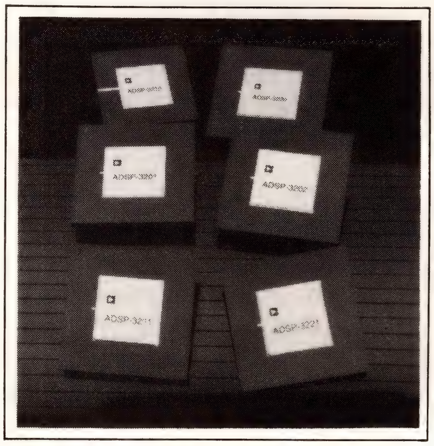
The IC has an on-chip highpass filter with a 300-Hz cutoff frequency, which you can switch into the transmit or receive signal path, to provide audio prefiltering or rejection of the received CTCSS tones, respectively. The FX365 operates from a 5V supply and draws 3.5 mA typ. On-chip clock circuitry generates all frequency timing from a 1-MHz crystal or an external clock source. The device is available in a 24-pin DIP or in a 24- or 28-pin surface-mount package. Approximately £7.75 (1000).

Consumer Microcircuits Ltd, Wheaton Rd, Industrial Estate East, Witham, Essex CM8 3TD, UK. Phone (0376) 513833. TLX 99382.

Circle No 380

Mx-Com Inc, 4800 Bethania Station Rd, Winston-Salem, NC 27105. Phone (919) 744-5050.

Circle No 381



DSP CHIPS

The ADSP-3211 floating-point multiplier achieves throughput to 20M flops and 5M flops for single- and double-precision operations, respectively. The ADSP-3221 floating-point arithmetic-logic unit (ALU) incorporates new instructions for IEEE divide and square-root operations. Each has a lower-cost, 10M-flops, single-precision version: the ADSP-3201 multiplier and ADSP-3202 ALU. All four products use 1.5-µm CMOS technology and come in 144-pin pin-grid arrays.

The ADSP-3211, for example, has two 32-bit input ports and one 32-bit output port, and it performs single-precision, floating-point multiplica-

Text continued on pg 154

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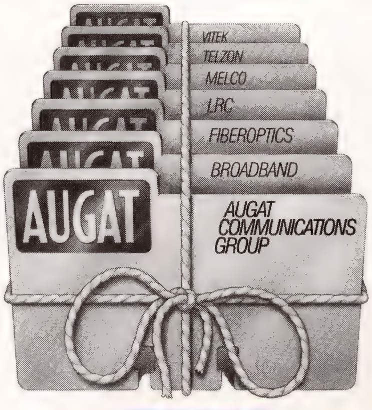
For more information on the *one* company that has the products, the capability and the experience to tie fiber, coax and twisted pair into a common network, contact Augat Communications Group, PO Box 1110, Seattle, WA 98111. Call us at 206-223-1110.



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Our ACL is faster than FACT. GE/RCA ACL uses a 1.5 micron channel length N-well CMOS process resulting in an on-chip gate delay of only 0.7ns.

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ACL power dissipation is typically less than 25% of a FAST bipolar device. ACL dissipates less than a quarter of one Watt while switching, compared to one full Watt for a FAST IC (transceiver operating at 5 MHz). Quiescent power savings are even more dramatic. ACL idles at 1/1000 the power of a FAST IC (.5mW vs. .5W).

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Our ACL line is priced comparably to FAST, so your savings with CMOS low power pay for the cost of switching.

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For more information, call toll-free: 800-443-7364, extension 11. Or contact your local GE/RCA sales office or distributor.

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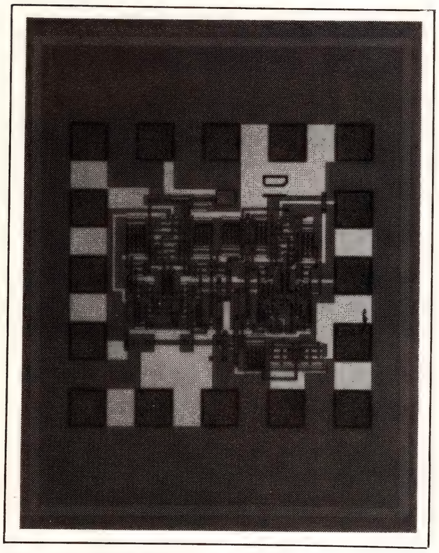
Call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, 0276-685911; Milano, (2) 82-291.

GE RCA

tion with a latency of 140 nsec. Parts are specified for operation over the commercial and military temperature ranges. ADSP-3201 and ADSP-3202, from $97; ADSP-3211 and ADSP-3221, from $300 (100).

Analog Devices Inc, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 461-3672.

Circle No 382



GaAs PRESCALER

The monolithic ADV 3040 is a GaAs, 3-GHz, divide-by-4 prescaler for microwave and high-frequency-synthesizer applications. The device provides ECL-compatible output levels over the range 0.8 to 3 GHz, and it operates over the military and commercial temperature ranges. Its specifications include −130-dBc/Hz phase noise, 50Ω input impedance, and a 1.5:1 input VSWR. The single-sideband phase noise at 10 kHz does not contribute to the noise sidebands of a microwave source locked in a wideband phase-locked loop, nor does the phase noise add to the noise floor of a phase-locked signal source when that source uses a 10-MHz crystal as its reference. Commercial-grade version in an 8-pin flat pack, $77 (1000).

Anadigics Inc, 35 Technology Dr, Warren, NJ 07060. Phone (201) 668-5000. TLX 510-600-5741.

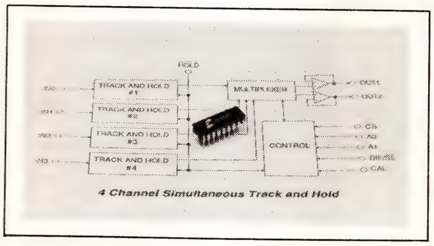
Circle No 384

STATIC RAMs

The MB84256 family of 256k-byte static RAMs offers access times as fast as 100 nsec. The MOS parts are TTL compatible and come in JEDEC-standard 28-pin DIPs, 28-pin gull-wing plastic flat packs, and 32-pad leadless chip carriers. Standard versions offer 100-, 120-, or 150-nsec access times; they dissipate 385 mW in active mode, 16.5 mW in standby. For lower-power applications, the MB84256L and MB84256LL draw only 50 and 5 μA, respectively, in standby mode. The 100-nsec version, $27.95 (100).

Fujitsu Microelectronics Inc, Marketing Communications, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000. TWX 910-338-0190.

Circle No 385



QUAD TRACK/HOLD IC

The Model CS31412 monolithic quad track/hold IC offers 12-bit accuracy and a 1-μsec acquisition time. You can configure the input multiplexer to accept four single-ended signals or two differential signals. Each of the IC's four track/hold amplifiers includes a hold capacitor; the voltage droop is only 0.01 μV/μsec. The device also includes a RAM-based calibration scheme that reduces the total unadjusted error—including nonlinearity, gain error, and hold-pedestal error—to 700 μV max over time and temperature. The CS31412 comes in an 18-pin ceramic DIP, operates on ±5V supplies, and dissipates 250 mW. To simplify its evaluation, you can buy the CDB31412 demo board, including a socketed IC, for $100. CS31412, from $36 (100).

Crystal Semiconductor Corp, Box 17847, Austin, TX 78760. Phone (512) 445-7222.

Circle No 388

BAR-GRAPH ADC

Model ICL7182 is an A/D converter that not only directly drives a multiplexed LCD but also requires only three external components to drive a 101-segment bar graph. The monolithic, silicon-gate CMOS device consumes 1.8 mW typ. Analog and reference inputs are fully differential (the chip includes a 2.56V bandgap reference). Guaranteed specs include less than 0.5% error for nonlinearity and zero offset at a 1V full-scale input. The full-scale differential input range is 200 mV to 1.1V. The part comes in a 40-pin DIP. $8.95 (100).

GE/Intersil, 10600 Ridgeview Ct, Cupertino, CA 95014. Phone (408) 996-5000. TWX 910-338-0171.

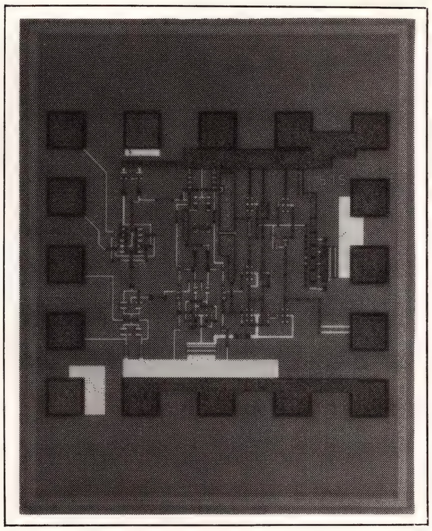
Circle No 383

DATA ACQUISITION

The HS9414 is a self-contained, 12-bit data-acquisition system in a 2.1×0.8-in., 40-pin DIP module. It includes a 4-channel, differential-input multiplexer and an instrumentation amplifier that has digitally programmable gains of 1, 10, 100, and 500. The module also includes a 10V reference, an S/H amplifier, and a 574-type A/D converter. The system's throughput ranges from 8.2k samples/sec (with 0.02% accuracy) at a gain of 500 to 24k samples/sec (with 0.01% accuracy) at a gain of 1. You can improve the throughput by pipelining the selection of mux channels. The module's power-supply requirements are ±15 and +5V. It dissipates 980 mW typ, 1300 mW max. HS 9414C, $119; HS 9414B, $220. Delivery, six to eight weeks ARO.

Hybrid Systems Corp, 22 Linnell Circle, Suburban Industrial Park, Billerica, MA 01821. Phone (617) 667-8700.

Circle No 386



GaAs OP AMP

The AOP 3510 GaAs op amp offers a 1200V/μsec slew rate, 20-nsec settling time, 70-dB open-loop gain, and 350-MHz unity-gain bandwidth. The part is suitable for application in such products as A/D- and D/A-converter amplifiers, S/H amplifiers, fiber-optic systems, and LANs. The amplifier comes in a 16-pin DIP or in die form. A commercial-grade version in a 16-pin DIP (AOP 3510 J3C) costs $32.75 (1000).

Anadigics Inc, 35 Technology Dr, Warren, NJ 07060. Phone (201) 668-5000. TWX 510-600-5741.

Circle No 387

A/D CONVERTER

According to its manufacturer, the HS 9476 is the first hybrid 16-bit A/D converter to include an S/H amplifier in the package. The combination supports typical conversion rates as high as 50k samples/sec with 14-bit resolution and 45.4k samples/sec with 16-bit resolution. At 14-bit resolution, the device specifications guarantee no missing codes over the operating range 0 to 70°C. Input ranges include ±5V, ±10V, 0 to 10V, and 0 to 20V.

Other specs include an integral linearity error of 0.003% full-scale resolution (FSR), a differential linearity of 0.006% FSR max, and gain and linearity drifts of ±2 ppm/°C max. The HS 9476 operates from

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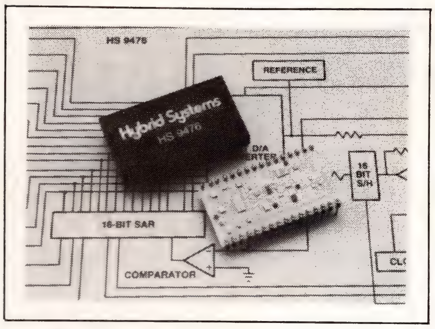


±15V and 5V supplies, consumes 1520 mW max, and is pin compatible with the HS 9576, the Burr Brown ADC 76, and the Analog Devices 376. It is packaged in a 32-pin DIP. HS 9476J, $180 (100). Delivery, four to six weeks ARO.

Hybrid Systems Corp, 22 Linnell Circle, Billerica, MA 01821. Phone (617) 667-8700. TWX 710-347-1575.

Circle No 394

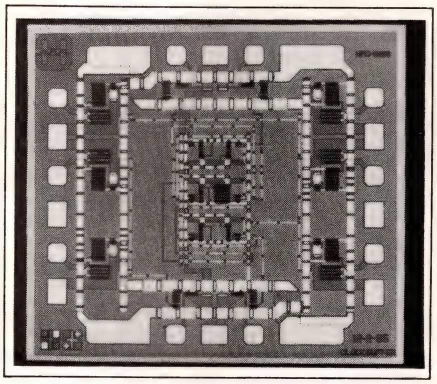
CMOS TIMER

The Model S-8081B is a CMOS IC that includes an RC oscillator, a 20-stage divider, a power-on clear circuit, and a circuit that prevents chattering at the trigger input. The IC also has a voltage reference that stabilizes the oscillator, and it includes level shifters and an output transistor. An inverted trigger output and set/reset controls are available. The device operates from a 4.5 to 16.5V supply and draws 200 μA max with the output open. It comes in an 8-pin plastic DIP. $2 (1000). Delivery, stock to eight weeks ARO.

Seiko Instruments USA Inc, 2990 W Lomita Blvd, Torrance, CA 90505. Phone (213) 530-8777.

Circle No 390

GaAs BUFFER



The HMD-11188-2 is a GaAs dual-clock-driver/fan-out buffer that's ECL compatible but four times faster than equivalent ECL devices. The buffer features a 1.8-GHz clock speed and 800-psec typ propagation delay. Quad outputs provide fan-out to four 50Ω transmission lines with less than 50 psec of skew among them. A mode control lets you complement these outputs, and a third input lets you enable and disable the output data. A second driver circuit, independent of the first, provides a noninverting fan-out of two outputs. The buffer operates within the range of −55 to +85°C and comes in a 16-pin hermetic flatpack. $155 (100). Delivery,

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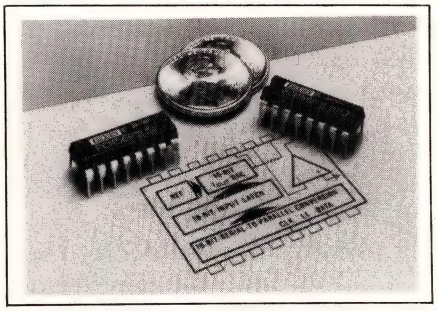
Harris Microwave Semiconductor, 1530 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 262-2222. TWX 910-338-2247.

Circle No 391



D/A CONVERTER

Suitable for use in compact-disk players, the 16-bit, serial-input PCM56P is a complete D/A converter that includes a zener voltage reference, thin-film resistors, current switches, and a high-speed, low-noise-output op amp. The converter's output voltage settles to within ±0.006% FSR in 1.5 μsec, and the maximum total-harmonic distortion is 0.0025%. The unit is monotonic to a 15-bit resolution and dissipates only 260 mW max when operating from 5V supplies. The device can also operate from ±12V supplies. It comes in a 16-pin plastic DIP. Based on preliminary data, the estimated MTBF is three million hours at 35°C. $12 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491. TWX 910-952-1111.

Circle No 395

FIFO MEMORY

Providing asynchronous data transfer between digital systems, the MA7001 512×9-bit FIFO memory allows you to write and read FIFO data simultaneously. It has an access time of 55 nsec and a read/write cycle time of 75 nsec. FIFO-full and FIFO-empty flag outputs allow you to avoid data overflow or underflow, and a retransmit feature allows you to reset the read pointer to its initial value so that you can retransmit the data contained in the FIFO.

Expansion logic in the device allows you to expand a FIFO system's word size or depth by using multiple devices. The FIFO memory is fabricated using fully static silicon-on-sapphire (SOS) CMOS technology. It's pin compatible with the MK4501 and IDT7201 FIFOs and comes in a 28-pin LCC or DIP. £18 (100).

Marconi Electronic Devices Ltd, IC Div, Lincoln Industrial Park, Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

Circle No 392

Marconi Electronic Devices Inc, 80 Smith St, East Farmingdale, NY 11735. Phone (516) 756-1900.

Circle No 393

Brooktree

Matrox PG1280A. 1280x1024 resolution color display processor board. Displays 256 colors from either a 4,096 or 16.8 million color palette.

Bt451/Bt458. Triple 4bit/8bit RAMDAC family. Both 125 MHz with 256 color palette. TTL Compatible.

Brooktree Corporation, 9950 Barnes
Canyon Road, San Diego, California
92121. 1-800-VIDEO IC or
1-800-422-9040, in California.

CIRCLE NO 13

GRAPHICS CHIP

With the addition of a few external components, the monolithic MC10320 provides the complete interface between a color monitor and its controlling computer. The device contains three 4-bit video D/A converters, a 12-bit×16-location color palette (RAM), a voltage reference, and the necessary latches. The chip is compatible with most digital systems because the input and output circuits have separate power-supply terminals; you can connect a 5 or −5V supply to accommodate either TTL or ECL.

Specs include a guaranteed 125-MHz pixel rate, 750-mW typ power dissipation, a glitch area of 20 pV/sec, and a 3-nsec settling time. Differential and integral nonlinearity errors are ±¼ LSB. $46.08 (1000).

Motorola Inc, Semiconductor Products Sector, Box 52073, Phoenix, AZ 85072. Phone (602) 897-3872.

Circle No 396

QUAD COMPARATORS

The LP165 and -365 are quad, 139-type comparators fabricated on monolithic bipolar ICs. By adjusting a programmable set current, you can trade response time and output-drive capability for power dissipation. Each comparator has an uncommitted output-emitter connection that you can configure as an interface to TTL, DTL, CMOS, NMOS, and PMOS logic families. The comparators can operate from a single or a split power supply (4 to 36V, or ±2 to ±18V). The inputs' common-mode range includes the most negative supply rail. The devices are specified for the commercial or military temperature ranges and are packaged in 16-lead plastic or ceramic DIPs. Commercial version, $1.55; military, $1.93 (100).

Raytheon Co, Semiconductor Div, 350 Ellis St, Mountain View, CA 94043. Phone (415) 968-9211.

Circle No 406

ANALOG SWITCH

The CDG201B quad-spst analog switch has TTL-compatible control inputs. Pin- and function-compatible with industry-standard DG201 switches, the monolithic device combines CMOS and DMOS (double-diffused MOS) technology. The switches offer a wide bandwidth, with less than 1-dB rolloff at 100 MHz. The off isolation is 70 dB at 10 MHz, 40 dB at 100 MHz. The analog input range is ±10V using ±15V supplies. Chips are available in die form or housed in 16-pin DIPs. Industrial version, $2.45 (100). Delivery, six weeks ARO.

Topaz Semiconductor, 1971 N Capitol Ave, San Jose, CA 95132. Phone (408) 942-9100. TWX 910-338-0025.

Circle No 403

GaAs LOGIC

An expansion of the Q-Logic family of GaAs devices provides products for fiber-optic systems and gigahertz-frequency-synthesizer systems. The new prices for this family make these the least expensive GaAs IC components available, according to the manufacturer. All parts operate at 1-GHz (min) clock rates and interface with ECL over their operating temperature range of 0 to 85°C.

Semicustom designs can also work with TTL and CMOS logic. The manufacturer will build semicustom GaAs ICs based either on your specifications or on electrical design and simulation that you perform with the manufacturer's workstation software. In either case, the company delivers packaged and functionally tested parts. Typical designs have 50 to 500 logic gates and six to 40 I/O pins. Engineering development for the manufacturer's designs, $100,000; for customer designs, $55,000 (single circuit). Workstation software, $495; standard products, depending on complexity and guaranteed speed, $60 to $300 (100).

TriQuint Semiconductor Inc, Group 700, Box 4935, Beaverton, OR 97076. Phone (503) 629-3535.

Circle No 389

16×16-BIT MAC

Based on the company's high-density bipolar VLSI process, the B3011 fixed-point multiplier-accumulator (MAC) provides an 11-nsec typ multiply-accumulate time for 16-bit inputs. This ECL-compatible chip is the industry's fastest, according to the manufacturer. The typical power dissipation is 5.5W. The chip's 40-bit accumulator, useful for complex-number and double-precision computations, has dual input registers and a 40-bit output. The MAC comes in a 132-pin pin-grid array. Commercial grade, $340 (100).

Bipolar Integrated Technology, 1050 NW Compton Dr, Beaverton, OR 97006. Phone (503) 629-5490.

Circle No 402

MOTOR-CONTROL IC

Designed for the control of 3-phase, variable-speed ac motors, dc brushless motors, or PWM converters, the MA 818P waveform-generator IC includes all the logic necessary to produce 3-phase PWM output signals. The chip controls three complementary electronic switch pairs, which may be MOSFET, bipolar, or GTO thyristor devices, and you can program delays into the output waveforms to maximize the efficiency of the complementary switching. You configure the waveform generator via a μP interface.

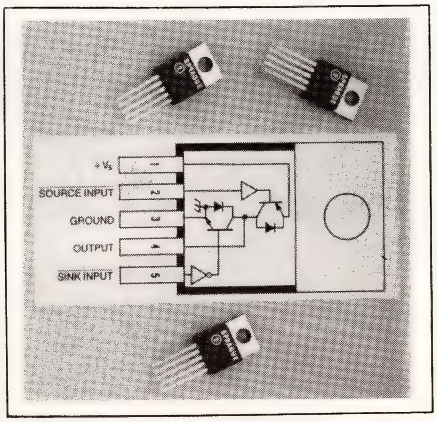
The MA 818P automatically inhibits narrow output pulses that are less than a preprogrammed minimum period; you can program this minimum period to be as short as 1 μsec. You can also switch the output phases to obtain forward or reverse motor rotation. The waveform generator accepts constant-carrier frequencies in the 600-Hz to 19.5-kHz range, and it has user-selectable power-frequency ranges of 0 to 50 Hz and 0 to 3 kHz. You can define the shape of the power frequency's waveform with data contained in an external ROM. The MA 818P is fabricated in CMOS technology with TTL-compatible inputs and outputs. £20 (100).

Marconi Electronic Devices Ltd, Lincoln Industrial Park, Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

Circle No 397

Marconi Electronic Devices Inc, 80 Smith St, Farmingdale, NY 11735. Phone (516) 420-8378.

Circle No 398



COPROCESSOR

The UDN-2943Z is a half-bridge motor driver with extensive protection circuitry. The 24V/1A device drives dc servo motors. You can also use the driver in pairs for full-bridge applications, or as triplets for 3-phase brushless dc motors. On-chip safeguards include thermal and overvoltage shutdown, cross-over-current protection by means of an internally generated dead time, and short-circuit protection (when the source driver is shorted to ground). Input-logic lockout, which prevents the source and sink drivers from turning on simultaneously, and transient suppression are other safeguards. The pulse-width-modulated driver features saturated outputs, which minimize power consumption. The device comes in a modified 5-lead, power-tab TO-220 plastic package. $1.35 (100). Delivery, 10 to 12 weeks ARO.

Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (617) 853-5000.

Circle No 401

Continued on pg 162

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CIRCLE NO 14

TIME TO KISS YOUR GOOD-BYE.

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While it's pin-compatible with the best known 24-pin PLDs, the ERASIC E^2 PLD gives you a lot more, like multi-level logic and reprogrammability. Multi-level logic lets you cascade your logic up to 42-levels deep, giving you the ability to create complex internal logic circuits (even with buried Flip-flops) without using valuable I/O pins. Flexibility like this can make life a lot easier for the logic designer who's struggling with the limitations of old-fashioned AND-OR logic planes.

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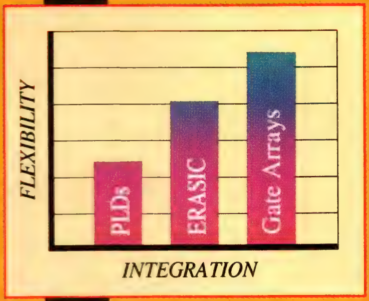

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CIRCLE NO 140

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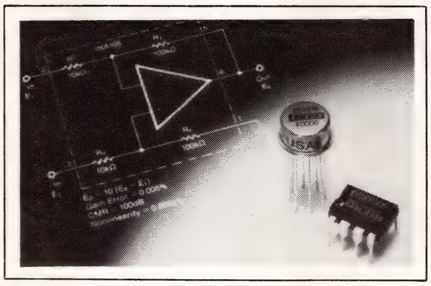
MULTIPLIERS

According to the manufacturer, the ECL-compatible ADSP-8018 and the TTL-compatible ADSP-7018 digital multipliers come with the industry's fastest multiply times—15 and 19 nsec max, respectively. Based on a bipolar process featuring a 2-μm device geometry, these products feature 300-psec gate delays and 300-μW/gate power dissipation. Each device dissipates less than 3.5W total. The 32-bit output port presents the product of a 16×16-bit multiply operation in one cycle; for 16-bit systems, you can multiplex the result through a single port.

Independent input, instruction-status, and output latches have a transparent mode of operation that simplifies system timing. The multipliers accept 2's-complement, unsigned-magnitude, and mixed-mode input code. Both devices come in 108-pin pin-grid arrays, spec'd for the commercial temperature range. ADSP-8018, $260; ADSP-7018, $205 (100).

Analog Devices Inc, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 461-3672. TWX 710-394-6577. TLX 174059.

Circle No 400



DIFFERENTIAL AMP

The INA106 differential amplifier provides a gain of 10 by combining a precision op amp and a 10- to 100-kΩ resistor network on a monolithic chip. Overall accuracy, including errors in gain, linearity, offsets, and CMR, is better than ±0.015%. The amplifier's 20-mA output (for positive output voltages) simplifies the design of 4- to 20-mA transmitter circuits.

Other specs include a minimum 100-dB CMR, a 5-μsec settling time (to ±0.01%), and a 2-mA quiescent supply current. The device comes in a TO-99 can or a plastic 8-pin DIP, spec'd for the commercial, industrial, or military temperature ranges. From $3.65 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491. TWX 910-952-1111.

Circle No 399

A/D CONVERTER

The THC1068 8-bit hybrid flash converter requires only a TTL clock and a bipolar analog input for operation. The device includes an input amplifier, a bandgap voltage refer-

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Nobody.

ence, and 3-state outputs. You program the pins of the device, which comes in a 24-pin DIP, to accept positive, negative, or bipolar analog inputs. The converter operates over the military temperature range and meets the test and reliability requirements of MIL-STD-883B, Rev C. Hybrid Systems (Billerica, MA) will be a second source. $375 (100).

TRW, LSI Products Div, Box 2472, La Jolla, CA 92038. Phone (619) 457-1000.

Circle No 404

DUAL UART

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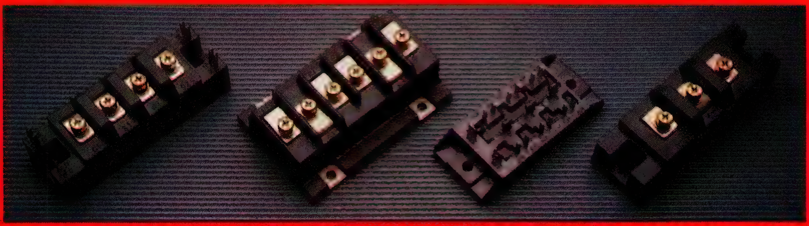

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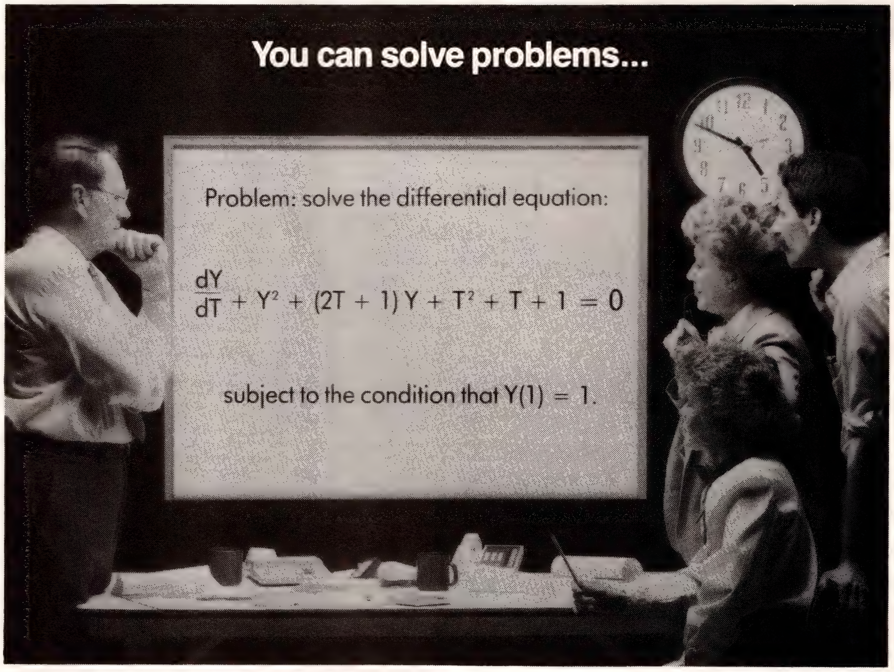

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```
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(C2) DIFF (Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
```

(D2) $\frac{dY}{dT} + Y^2 + (2T + 1)Y + T^2 + T + 1$

```
(C3) SOLN:ODE(D2,Y,T);
```

(D3) $Y = -\frac{\%C\ T\ \%E^T - T - 1}{\%C\ \%E^T - 1}$

```
(C4) SOLVE(SUBST([Y=1,T=1],D3),%C),NUMER;
(D4)      [%C = 0.5518192]
(C5) SPECIFIC_SOLN:SUBST(D4,SOLN);
```

(D5) $Y = -\frac{0.5518192\ T\ \%E^T - T - 1}{0.5518192\ \%E^T - 1}$

and Numerically.

```
(C6) FORTRAN(D5)$
        Y = -(0.5518192*T*EXP(T)-T-1)
     1       /(0.5518192*EXP(T)-1)
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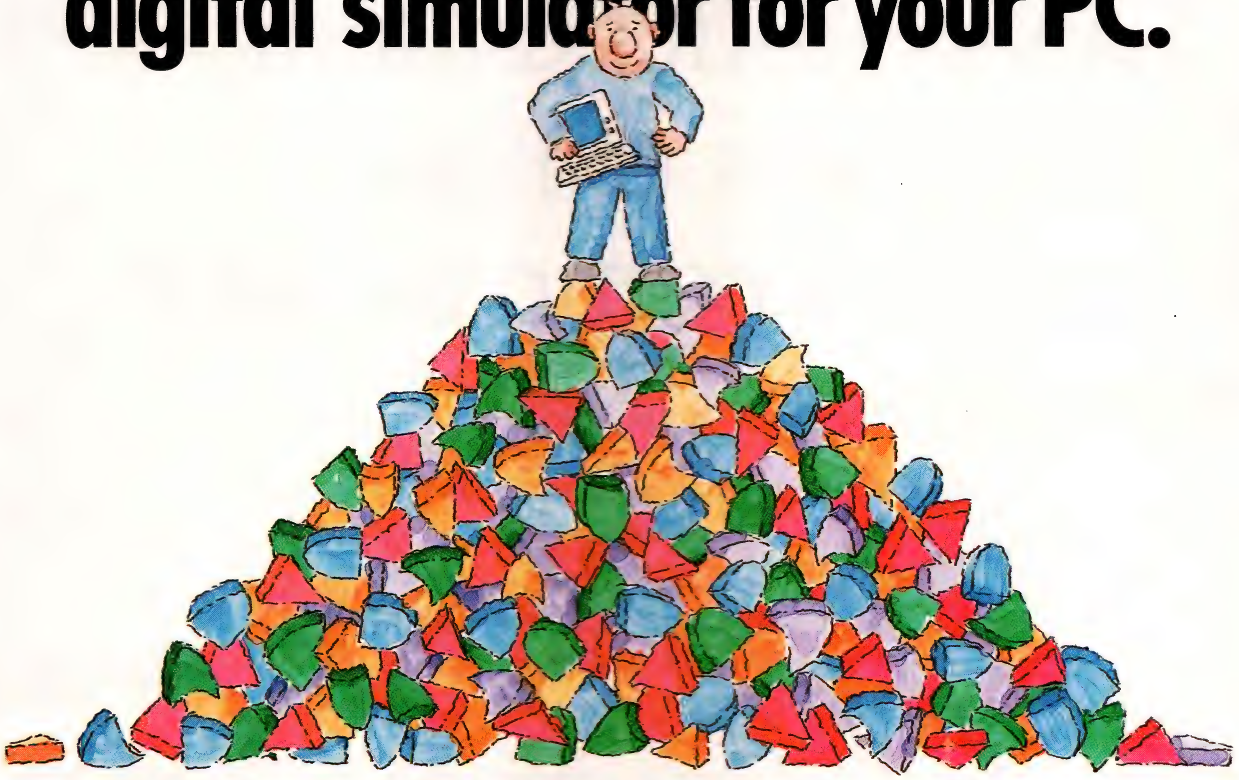

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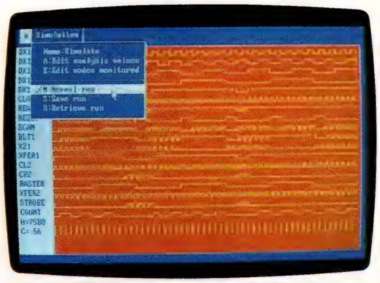

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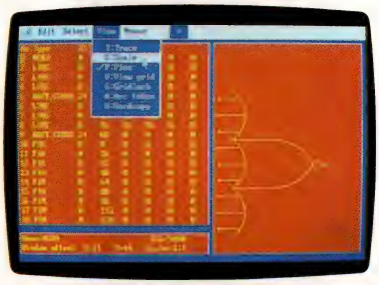

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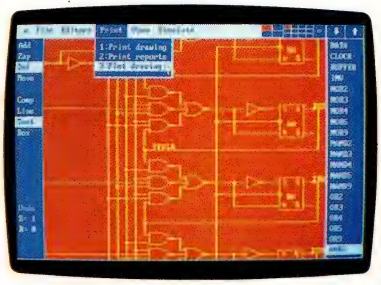

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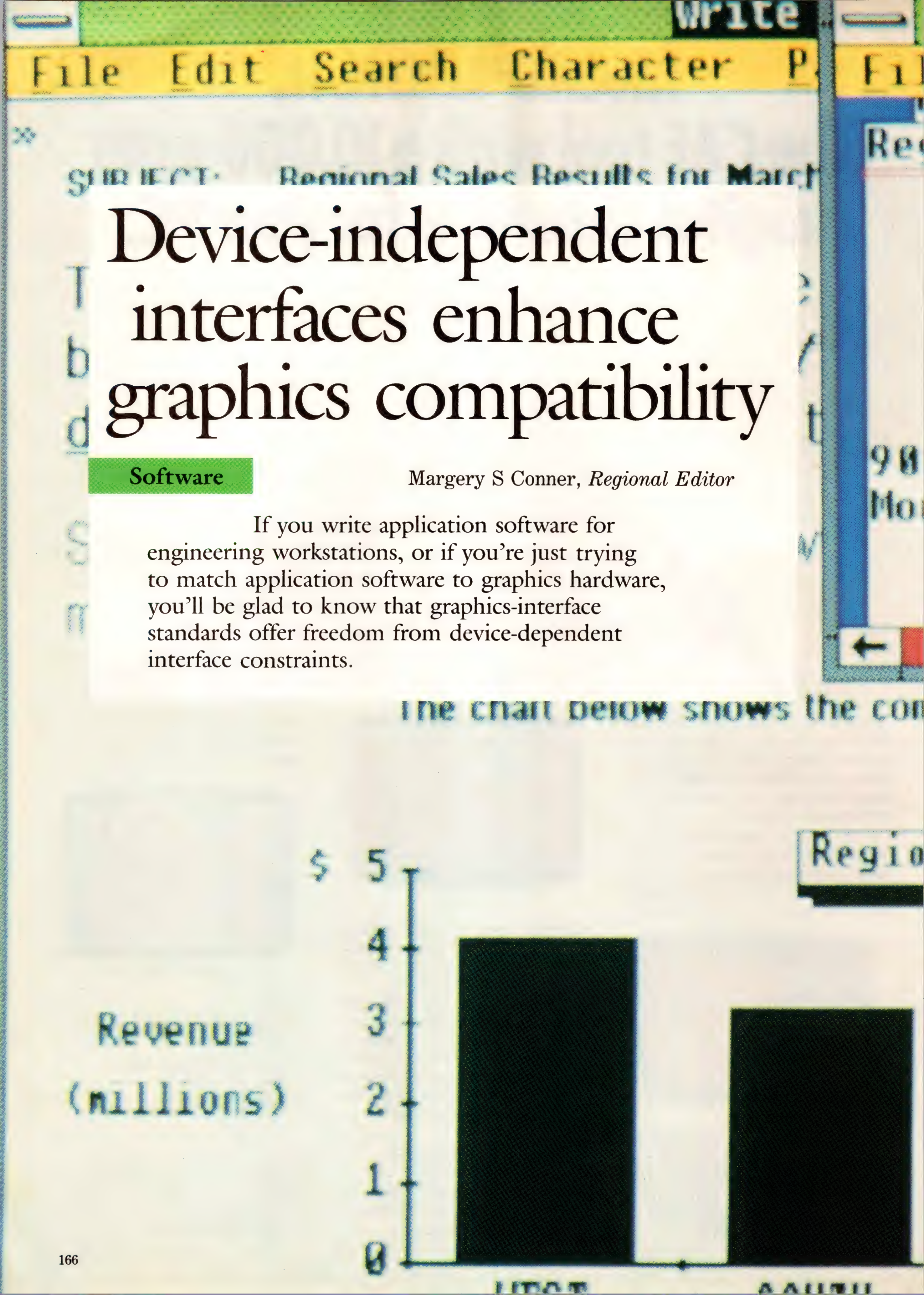
CIRCLE NO 167

Device-independent interfaces enhance graphics compatibility

Software

Margery S Conner, *Regional Editor*

If you write application software for engineering workstations, or if you're just trying to match application software to graphics hardware, you'll be glad to know that graphics-interface standards offer freedom from device-dependent interface constraints.



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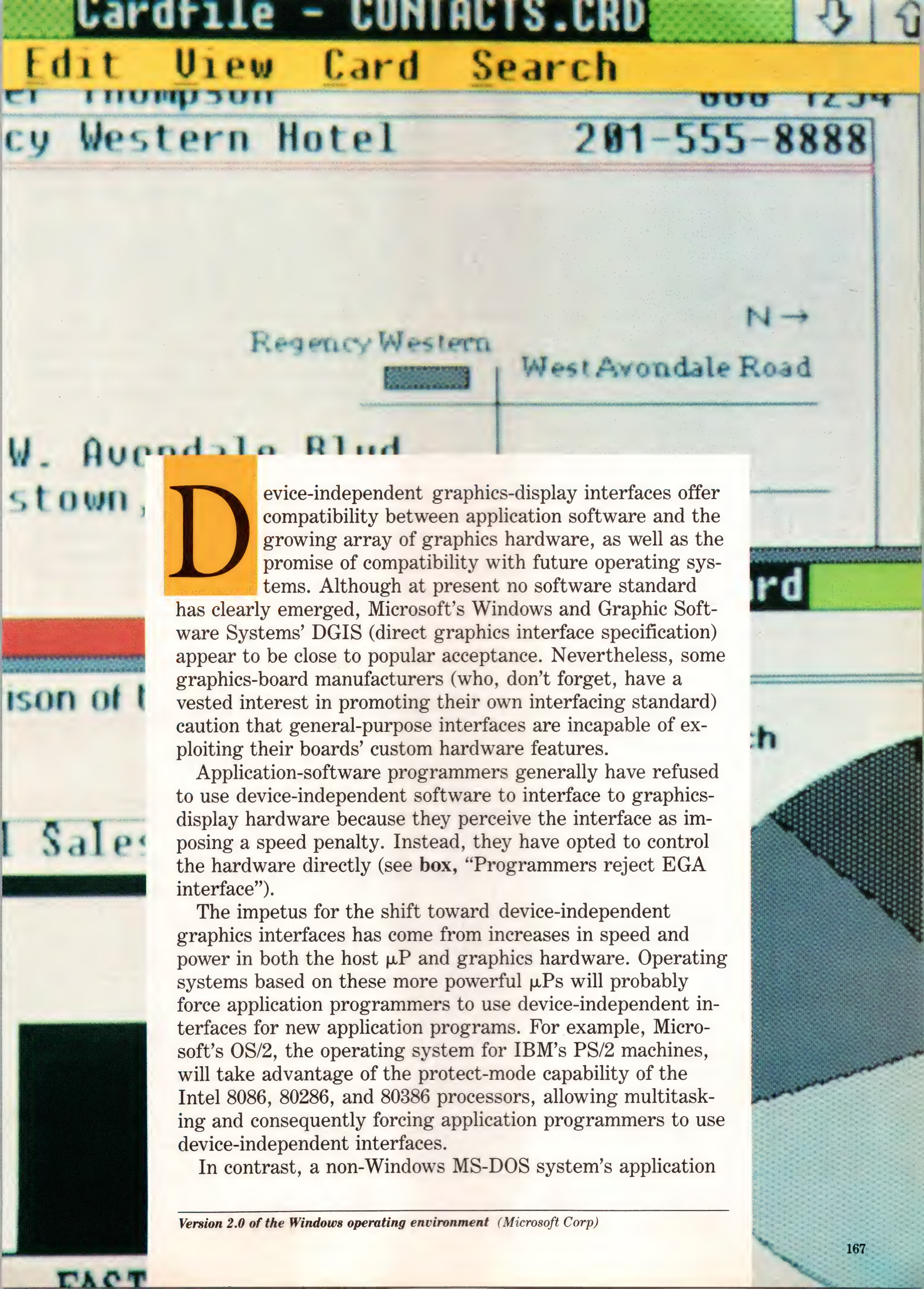


Device-independent graphics-display interfaces offer compatibility between application software and the growing array of graphics hardware, as well as the promise of compatibility with future operating systems. Although at present no software standard has clearly emerged, Microsoft's Windows and Graphic Software Systems' DGIS (direct graphics interface specification) appear to be close to popular acceptance. Nevertheless, some graphics-board manufacturers (who, don't forget, have a vested interest in promoting their own interfacing standard) caution that general-purpose interfaces are incapable of exploiting their boards' custom hardware features.

Application-software programmers generally have refused to use device-independent software to interface to graphics-display hardware because they perceive the interface as imposing a speed penalty. Instead, they have opted to control the hardware directly (see **box,** "Programmers reject EGA interface").

The impetus for the shift toward device-independent graphics interfaces has come from increases in speed and power in both the host µP and graphics hardware. Operating systems based on these more powerful µPs will probably force application programmers to use device-independent interfaces for new application programs. For example, Microsoft's OS/2, the operating system for IBM's PS/2 machines, will take advantage of the protect-mode capability of the Intel 8086, 80286, and 80386 processors, allowing multitasking and consequently forcing application programmers to use device-independent interfaces.

In contrast, a non-Windows MS-DOS system's application

Version 2.0 of the Windows operating environment *(Microsoft Corp)*

Regardless of which application is running, the screen setup (including icons and tiling characteristics) is the same.

software takes control of the system, relinquishing it only to request services or upon termination. Because only one task is resident at a time, each task can have virtually unrestricted access to the system. When, as in this case, the applications software writes directly to the graphics hardware, it uses a device-dependent interface.

Windows actually functions as more than just a graphics-display device-independent interface; it is an extension of the operating system. It forms an operating environment, which handles memory allocation, multitasking, and dynamic data exchange between simultaneously running application programs. The program also compels a consistent user interface: Regardless of which application is running, the screen setup (including icons and tiling characteristics) remains the same.

Application software running in the Windows environment communicates with the hardware through its GDI (graphics device interface), which defines a virtual device and conceals the specific hardware from the application. GDI is Microsoft's implementation of ANSI's proposed computer graphics interface (CGI). Note that the hardware graphics display must have a firmware interface to its GDI. The memory that this firmware requires is not insignificant; in a 34010-based graphics board, for example, the Windows' drivers require 196k bytes of RAM.

The Windows software costs $99. The development tool kit, which you need to create a Windows driver for your application software, sells for $495. The company also offers a seminar on developing Windows drivers.

Both OS/2 and MS-DOS can have Windows as their common operating environment, and for this reason application software running under a Windows environment in MS-DOS will have the same visual interface running under a Windows OS/2 environment. Although the application's graphics drivers will require some modification to run under Windows in OS/2, Microsoft claims the changes will be minimal.

The IBM PC world is not alone in its scrutiny of a device-independent graphics standard. X Windows, initially developed by MIT and having the advantage of being in the public domain, is a windowing interface for Unix-based systems. Device-independent interfaces in Unix environments haven't been surrounded by the same controversy as those in the MS-DOS world because Unix has always supported multitasking with device-independent drivers.

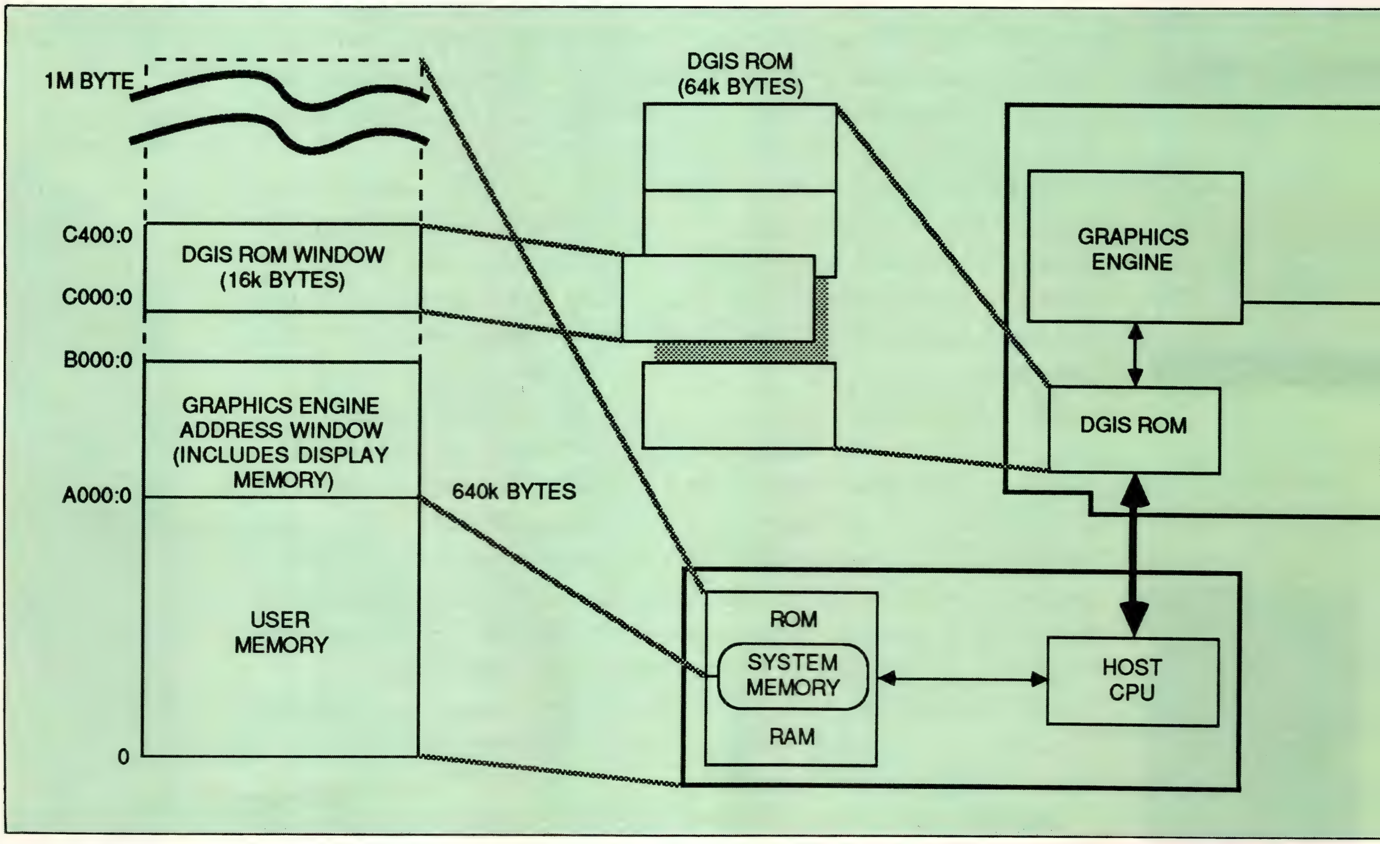


Fig 1—DGIS firmware on the intelligent graphics board *handles graphics-function calls from application software. To conserve memory, the board's hardware can switch the 64k-byte DGIS code in 16k-byte pages into the host processor's 640k-byte memory.*

Programmers reject EGA interface

When programming IBM's EGA (enhanced graphics adapter) hardware directly, software engineers must write programs that create drawings at the pixel level. Moreover, they must keep track of a complex matrix of mode and register commands so numerous that the technical-reference manual IBM supplies for the board can't specify them all.

IBM does offer the PC Graphics Development Toolkit for device-independent programming of the EGA. Developed by GSS and licensed to IBM, it provides a subset of CGI commands, which allow engineers to manipulate their drawings as a series of high-level pieces, instead of individual pixels.

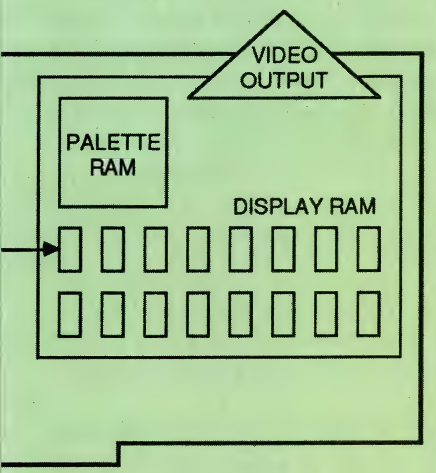
Most software vendors, particularly CAD/CAM companies, don't believe that the benefits bestowed by ease of programming and device independence outweigh the 5% penalty in response time caused by the interface's additional software overhead. For this reason, most companies have rejected the Development Toolkit. GSS argues that poorly written drivers can exceed this penalty. Of course, few software engineers will concede that one of their drivers might be inefficient.

An MS-DOS system's memory and multitasking capabilities are too limited for many PC/AT applications; you may want to run your PC/AT in a 32-bit environment. You can maintain compatibility with your MS-DOS software by running DOS as a task under Unix, using X Windows to switch back and forth between jobs.

Windows thumbs-up

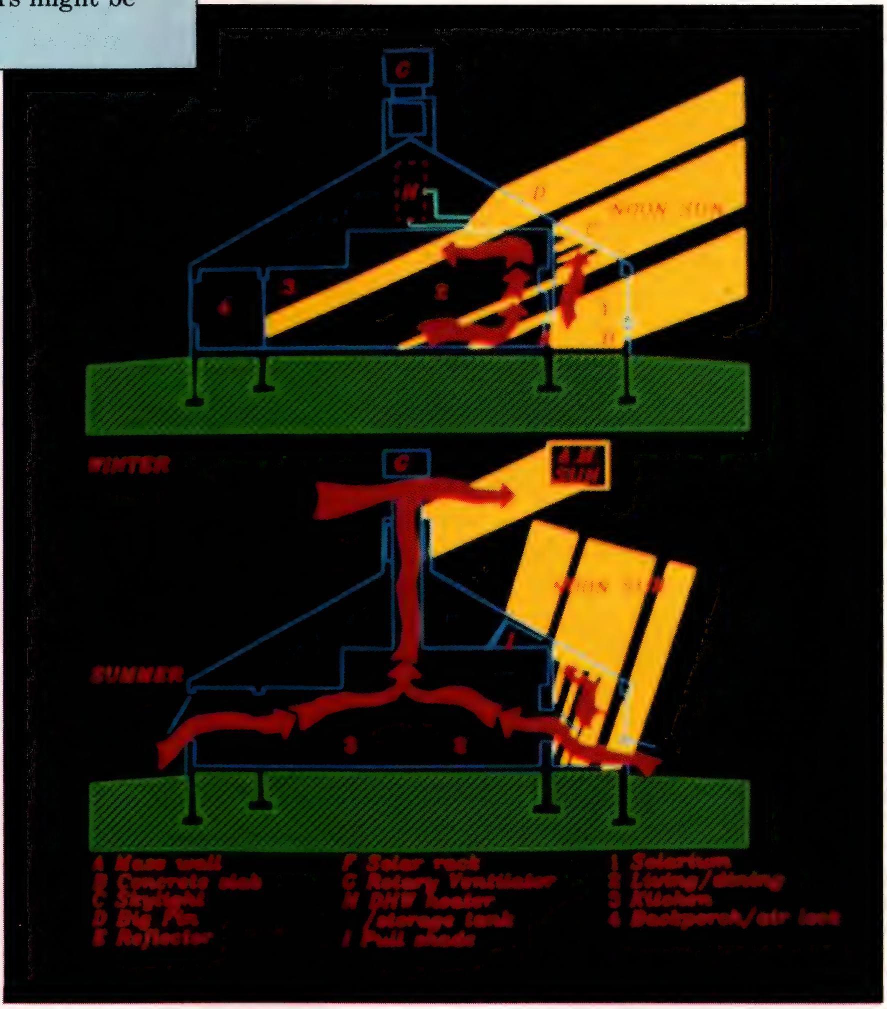
Allan Paller, president of AUI Data Graphics (Arlington, VA), a software consulting company, claims that Windows' device independence, combined with its consistent user interface, will establish it as the dominant method of interfacing to the PC. Its popularity will be fueled by support from the very group that has been resisting graphics interfaces up till now—the software-application vendors. He explains that software vendors want their programs to be compatible with the greatest number of boards, but they also don't want their programmers tied up writing device-dependent hardware drivers.

In addition, he credits the Macintosh with already



(COURTESY GRAPHIC SOFTWARE SYSTEMS)

Representative ***DGIS display*** *(Graphic Software Systems Inc)*



> **Allan Paller attributes the love affair that many users have with their Macs to the machine's windowed, friendly environment.**

establishing the credibility of the consistent user interface. He attributes the love affair that many users have with their Macs to the machine's windowed, friendly environment. This consistency and predictability also make it easy for programmers to write application software for it.

Paller readily admits that Windows must run on an 80286-based PC or higher; on an 8088-based machine, he says, it's too slow. In addition, the program is currently limited in its memory-support and windowing capabilities. (By the time this article is published, Windows Version 2.0 should be available. It will have overlapping windows and will support expanded-memory boards.)

Autodesk (Sausalito, CA), manufacturer of the Autocad package, is another vendor that is anticipating Windows' acceptance. John Sergneri, Autocad's product manager, has seen a lot of interest in Windows from the company's existing customer base. He claims that, because CAD programs often spend a great deal of time doing computation-intensive chores, the system is tied up and the user can't use it for other tasks. In a Windows multitasking environment, the user can run a communications program, for example, while Autocad performs its calculations.

Windows thumbs-down

Brian Cody, the product manager for Versacad (Huntington Beach, CA), disagrees with these predictions of Windows' acceptance as a standard. He claims that one of a CAD/CAM program's strengths is its custom user interface; a consistent user interface is constraining.

Moreover, Cody is concerned about the programming effort needed to adapt a program to Windows. Versacad has written over 60 device-dependent drivers for graphics boards, which represents a considerable programming effort. Cody hopes that an interface will emerge that will decrease or eliminate this effort; he believes Versacad's software resources are better spent developing new and improved versions of CAD programs.

For more information . . .

For more information on the device-independent graphics interfaces discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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However, because of the effort required to write a Windows driver, and the additional complexities of the Windows environment, Versacad has decided to support DGIS. The company is currently developing a hardware-independent driver for it. According to Cody, this programming task only requires days, instead of the weeks or months required to develop a Windows driver.

DGIS consists of a subset of CGI graphics primitives optimized for interfacing to graphics coprocessors in an MS-DOS environment, and it is similar in function to Microsoft's GDI. The firmware converts the DGIS graphics and text commands into coprocessor commands (**Fig 1**). Graphic Software Systems presently supports DGIS drivers for the Texas Instruments TMS34010, the Intel 82786, and the Hitachi ACRTC.

The interface's software-driver capabilities also include query commands to determine the characteristics of the graphics board, making DGIS-based programs portable between hardware of varying degrees of resolution and color capability. The vendor will license DGIS for your application for a fee of $20,000, including source code. It also offers DGIS for a royalty fee of $10 to $40 per unit, depending on quantity.

As application-software vendors weigh the relative merits of device-independent graphics interfaces, add-in graphics-board vendors view the emergence of a standard with trepidation. They can see the merits of accessing a large number of software packages by writing a Windows or DGIS driver for their board, but they also see tradeoffs. These interfaces are general purpose, and thus the software that uses them can't exploit any hardware accelerators unique to a particular board.

Sylvio Jelovitch, product manager for the PG-1281 Matrox graphics board, which is based on the Texas Instruments TMS34010 graphics engine, says that Matrox is undecided about supporting DGIS. The company does support Windows, though. (Note that it's more common for board manufacturers to support Windows than for software vendors to do so because the Windows hardware driver is much less complex than the software interfacing.) Matrox has four custom ICs on its PG-1281 board that accelerate graphics functions such as raster operation and hardware panning and zooming; DGIS doesn't support these. Matrox offers its own proprietary interfacing scheme to exploit these capabilities. (For more information on this subject, see "PC

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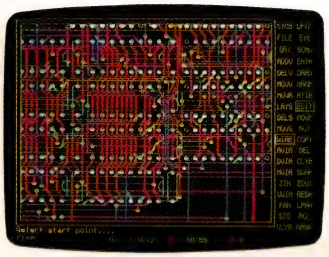

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CIRCLE NO 162

Interfaces allow varying levels of abstraction

CGI (ANSI's computer graphics interface standard) serves as a functional and syntactical specification of the control and data exchange between the device-independent graphics software and the device-dependent graphics device driver. It only pertains to 2-D data, deferring the complex transformations of data conversion to the modeling-software level.

Graphic Software Systems' DGIS (direct graphics interface specification) and Windows' GDI (graphics device interface) are subsets of CGI. The use of CGI is becoming more attractive as the cost of software grows relative to hardware costs in PC-based graphics systems.

Option sets allow the application software to adapt itself to the varying capabilities of graphics displays, such as the number of colors, resolution, and raster control. Note that CGI defines a virtual device and is unrelated to the hardware itself. You still need a device driver to adapt it to the hardware; in other words, it must be bound to the hardware.

A CGI implementation must be tailored to an operating system. Further, the application software is responsible for performing vector transformations. If you need to perform graphics manipulation at a more abstract level, you can use the graphical kernel system (GKS) or the programmer's hierarchical interactive graphics system (PHIGS). Both GKS and PHIGS provide an abstract model of the graphics and generate transformation matrices. PHIGS also supports 3-D modeling; a 3-D version of GKS, GKS-3D, is available.

The GKS- and PHIGS-level interfaces output graphics commands to the CGI level **(Fig A).** The software overhead introduced by this layering of interfaces usually precludes the use of GKS in personal computers, except where transportability among operating systems is an important consideration. (Actually, PHIGS is a new standard and has only received attention so far in high-end 3-D graphics workstations.)

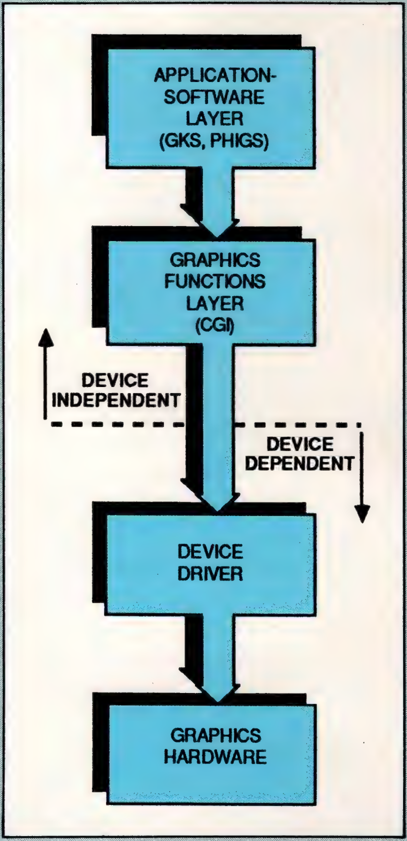
APPLICATION-SOFTWARE LAYER (GKS, PHIGS)
GRAPHICS FUNCTIONS LAYER (CGI)
DEVICE INDEPENDENT
DEVICE DEPENDENT
DEVICE DRIVER
GRAPHICS HARDWARE

Fig A—CGI specifies graphic subroutines for data exchanges between device-dependent and -independent levels. For more abstract programming, GKS and PHIGS can handle 3-D modeling and transformation matrices (at the applications-software layer).

add-in boards rev up graphics engines with hardware and software enhancements," EDN, June 25, 1987, pg 67.)

Such large graphics-board manufacturers have another reason to be wary of device-independent graphics interfaces: Once a software company commits to a board's hardware driver, the company is closely bound to that board because of the investment in programming and support time. With device-independent software, the software vendors aren't constrained and can be more flexible in terms of which board to support.

Some software-application vendors have to support a variety of computers and operating systems—they don't have the luxury of programming solely for the IBM PC. For these companies, a more abstract level of programming makes their programs portable between computer systems (see **box,** "Interfaces allow varying levels of abstraction"). GKS, for example, is more abstract than CGI and, by inference, Windows and DGIS. Nova Graphics has released a C-based version of the ANSI/ISO GKS standard, Nova*GKS, which costs $495 (object code only). You can license Nova*GKS, including source code, on a per site or corporate basis for a much lower per unit fee.

Jack Kramer, an engineer with Chemshare (Houston, TX), is working on a program with a GKS interface that combines a database with a CAD system. The package is capable of running on Prime computers and VAXs as well as PCs; he anticipates its migration onto engineering workstations. He points out that because GKS is accepted both in the US and in Europe, it's suitable for Chemshare's European client base. **EDN**

References

1. Grayson, Paul, "Windows of Opportunity," *PC Technology Journal*, February 1987, pg 56.
2. Wright, Maury, "Graphics card choice depends on compatible software," *EDN*, July 25, 1985, pg 56.

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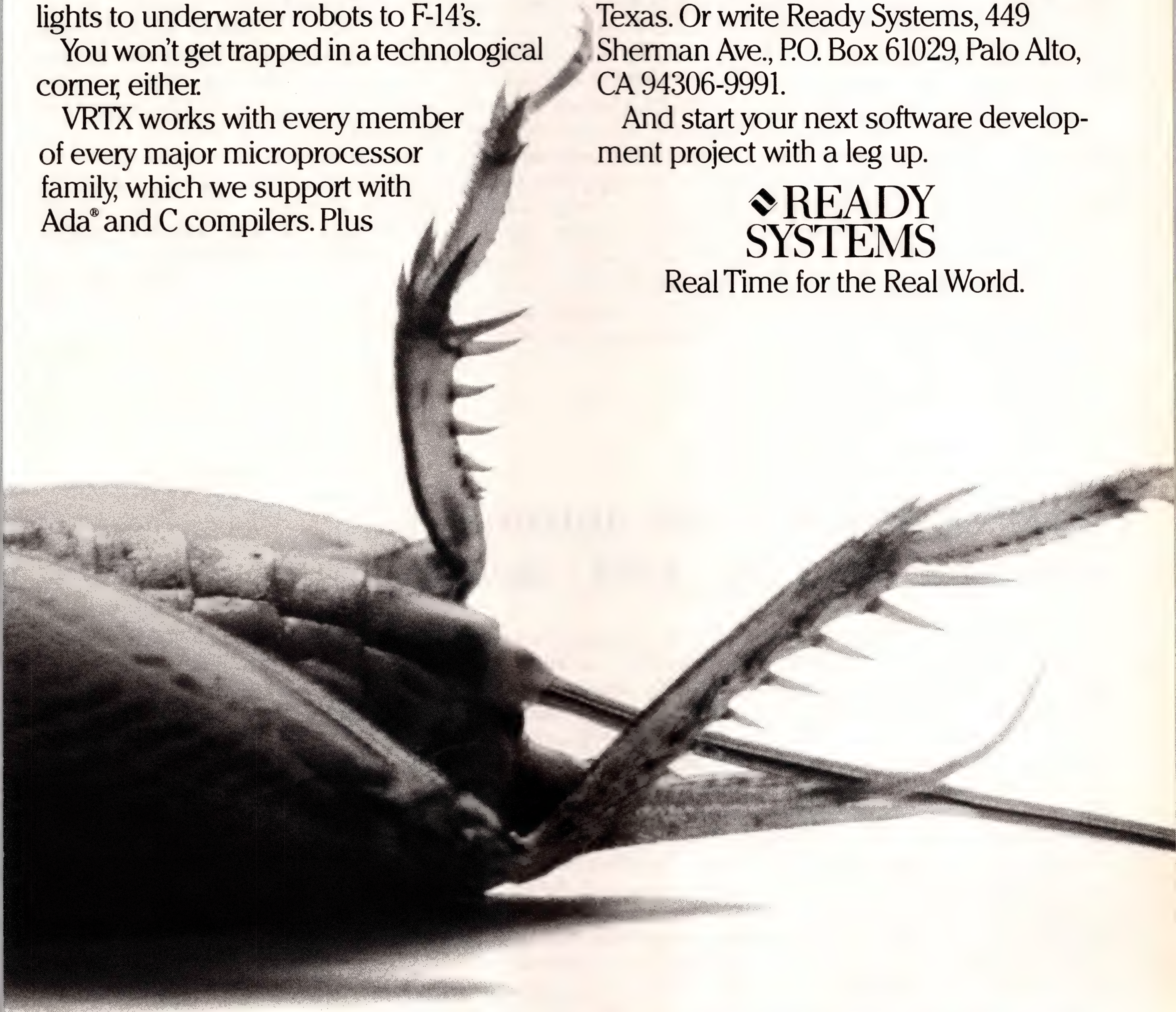

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CASE tool runs on a PC network and offers a choice of methodologies

vsDesigner is a set of tools for structured analysis and design that operates on an IBM PC/XT, PC/AT, or compatible workstation. You can run the PC in single-use, standalone mode, or as part of a 3COM, Novell, IBM Token Ring, or other network. The package lets you use the methodology of your choice (it offers DeMarco, Gane-Sarson, Warnier-Orr, Hatley, and others); if you wish, you can mix methodologies within a single design. If none of these is completely suitable for your application, you can define and use your own methodology and notation conventions. The flexibility of the system extends to the built-in word processor, which can emulate WordStar, Multimate, Word Perfect, VAX EDT, and other commonly used tools.

The program uses an object-oriented database, which can reside in your local disk storage or in the file server of a network, and which allows efficient communication among the members of a design team. Record locking preserves data integrity when the file is shared. On a network, each user can access all or part of a design from the database on another workstation or on the network file server. The hierarchical drawing editor lets you decompose your drawings to any number of levels. At each level of decomposition you can store, retrieve, or modify the graphical representation of the design, written design specifications, design reviews, notes, and source code for each module. At each level, the total drawing area is equivalent to 64 screens, and you can quickly browse through these by means of a virtual-display feature. An extensive, context-sensitive, on-line help feature provides quick answers to your questions while you're using the tools.

Visual Software Inc, 3945 Freedom Circle, Suite 540, Santa Clara, CA 95054. Phone (408) 988-7575. TWX 650-319-4164.

Circle No 578

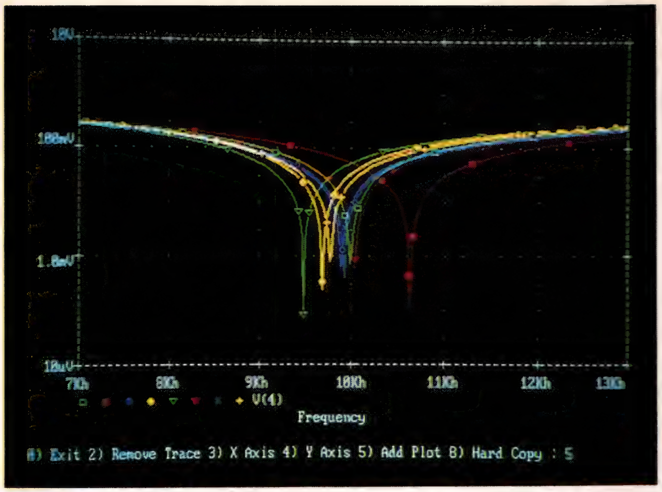
Timing-analysis tool automates timing checks for ASIC designs

The VLSI Timing Analysis Tool (VITAT) is an optional addition to the vendor's VLSI-design system (VISYS). It uses the same database and models that the other VISYS tools use. The vendor recommends that you run the program after completing your functional simulation and before running the standard pattern-driven timing simulations. VITAT checks your point-to-point timing and signal-skew specifications; it checks the setup times, hold times, and clock skews for all storage elements. The program reports marginal conditions, as well as outright violations of the specifications, thereby alerting you to potential problems that you might not be able to identify from the pattern checks, either because the patterns are not comprehensive enough or because of the difficulties of interpreting the results of pattern-driven simulations.

The tool advises you which sections of your design need to be modified or examined closely because of race conditions, reconvergent fanout, or feedback conditions. In addition, you can use the tool to explore the effects of changing the design parameters. You can include variables in the expressions that define signals or specifications, and by gradually increasing clock speed, for example, you can find the design's maximum operating speed. VITAT runs on DEC VAX systems and Mentor Graphics Idea workstations, and a version for Daisy workstations is in preparation. The price depends on the workstation configuration, but is under $10,000 in all cases.

NCR Microelectronics Div, 2001 Danfield Ct, Fort Collins, CO 80525. Phone (303) 223-5100.

Circle No 577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100mV
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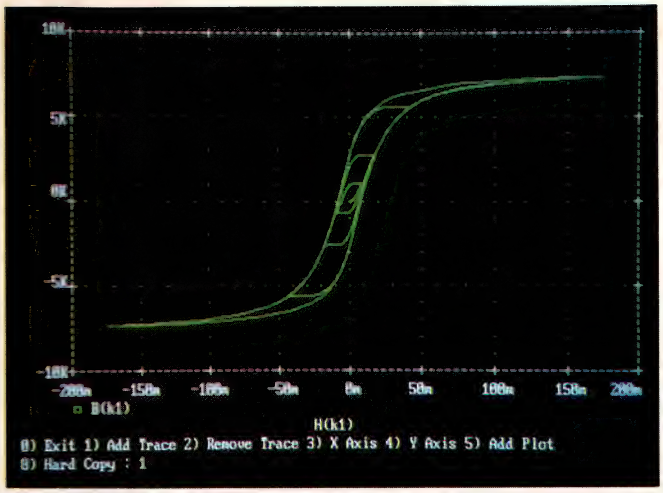
7Kh
8Kh
9Kh
10Kh
11Kh
12Kh
13Kh
V(4)
Frequency
0) Exit 2) Remove Trace 3) X Axis 4) Y Axis 5) Add Plot 8) Hard Copy : 5

Monte Carlo analysis of a notch filter



B-H curve from a core in the PSpice transformer library

PSpice

The Standard for Analog Circuit Simulation

Since its introduction just over three years ago, MicroSim's PSpice has sold more copies than all other SPICE-type simulators combined. Why do so many engineers choose PSpice? *Perhaps because every copy of PSpice includes these features:*

- Standard, non-encrypted, parts libraries for diodes, bipolar transistors, power MOSFET's, opamps, voltage comparators, and transformer cores.
- GaAs MESFET devices.
- Non-linear transformer devices modeling saturation, hysteresis, and eddy current losses.
- Ideal switches for use with, for example, power supply and switched capacitor circuit designs.

Or perhaps because of these innovative options available for PSpice:

- Monte Carlo analysis to calculate the effect of parameter tolerances on circuit performance.
- The Probe "software oscilloscope", allowing interactive viewing of simulation results. The photographs above are Probe displays.
- The Parts parameter extraction program, allowing you to extract a device's model parameters from data sheet information.
- The Digital Files interface, allowing you to transfer data from your logic simulator to (or from) PSpice. The interface performs the necessary D to A or A to D conversions.

Or perhaps because PSpice is available on these computers:

- The IBM PC family, including the new PS/2 and the COMPAQ 386.
- The Sun 3 workstation.
- The VAX/VMS family, including the Micro VAX II.

Or perhaps it is our extensive product support. Our technical staff has over 50 years of experience in CAD/CAE and our software is supported by the engineers who wrote it. With PSpice, expert assistance is only a phone call away.

If for any of these reasons PSpice interests you, please call or write today for a free demo copy of PSpice. Find out for yourself why PSpice is the standard in analog circuit simulation.

MicroSim Corporation

23175 LaCadena Drive
Laguna Hills, CA 92653 (714) 770-3022
(800) 826-8603 • Telex 265154 SPICE UR

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CIRCLE NO 153

Link software integrates real-time kernel in Unix

VME Bus CPU cards that are capable of providing a complete Unix environment on a single board allow Unix and real-time operating systems to coexist in a VME Bus system without introducing undue bus contention. For such a system, the TSVME791 software package provides a communications link between Unix System V and the pSOS real-time operating system, allowing these two operating systems to utilize each other's resources.

Communication between the two operating systems takes place over the VME Bus via shared memory located on the board running pSOS. The software package includes Unix and pSOS drivers, which operate through the standard Unix and pSOS kernel I/O systems, and which allow bidirectional communication between the two operating systems. You can link as many as 16 pSOS boards into Unix; each board can handle 16 separate I/O channels. From Unix, the I/O channels are accessed in the same way that standard peripheral-equipment channels are accessed.

You can use a Unix-based high-level-language compiler to develop assembly language for ROMable, position-independent code for 68000-family μPs. You can then download the code to the pSOS board. To debug the generated code, you can control pPROBE (the debug monitor that comes with pSOS) from the Unix terminal.

The Unix and pSOS operating systems can also communicate during run time. Using the Unix- and pSOS-based monitor tasks that accompany the software package, you can give Unix tasks the ability to simulate the execution of pSOS system calls, and vice versa. These capabilities allow you to synchronize Unix and pSOS tasks, for example, or to give pSOS tasks direct access to the Unix system's files.

The software package costs about Frfr 12,000. It comes as binary code on a floppy disk for use on the company's VME Bus Unix machines. For other machines, the source code of the Unix driver is available under certain conditions.

Thomson Semiconducteurs, Microsystems Div, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

Circle No 605

Thomson Components-Mostek Corp, 7950 E Redfield Rd, Scottsdale, AZ 85260. Phone (602) 951-2900.

Circle No 606

Real-time OS brings multiprocessing capability to 32-bit VME Bus systems

The UniFLEX/MP real-time operating system is now available for VME Bus multiprocessor systems based on 32-bit μPs in the 68000 family. This OS is modeled closely on Unix, but provides a set of commands that many users find more intelligible and easier to use than those of Unix. The system is available for the vendor's CPU-20/21 processor boards, which use the 68020 μP, and it runs with no wait states at clock speeds as high as 20 MHz. Each processor in the system can have as many as 4M bytes of RAM.

Because the OS is written in assembly language and is optimized for real-time multiuser systems, the vendor claims, you can easily partition the real-time tasks with very little system overhead. The C compiler is optimized for the 68020 instruction set and the 68881 floating-point coprocessor. Both the C and the Fortran compilers that come with the OS can make full use of the 68881 coprocessor. The OS also allows you to run third-party compilers for Lisp, Modula-2, and Prolog. Single-user license, $800.

Force Computers Inc, 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410. TLX 172465.

Circle No 579

Force Computers GmbH, Daimlerstrasse 9, D-8012 Ottobrunn, West Germany. Phone (089) 600-910.

Circle No 580

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CIRCLE NO 160

2-D and 3-D drafting tools provide mainframe features on a PC

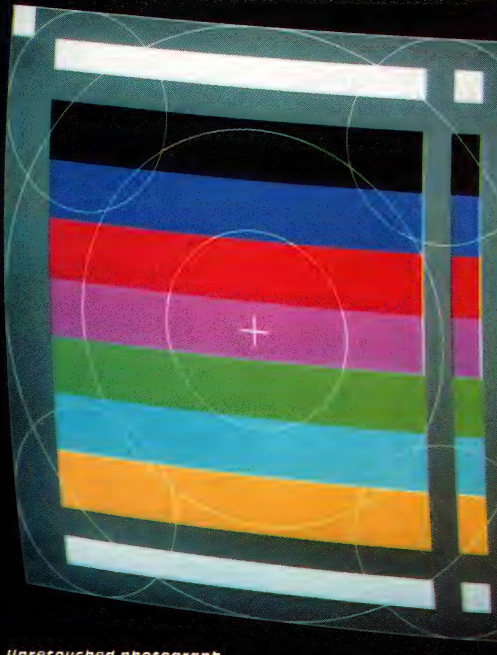
UltraCADD is a set of three design and drafting tools that run on the IBM PC/AT and compatibles. Model 240 is a basic 2-D design and drafting tool that accepts commands in plain English and has a color-coded, hierarchical command structure. Model 320 is a 3-D design and modeling tool derived from Mega CADD Inc's Design Board Professional; however, the vendor has completely redesigned the user interface to provide pop-up, color-coded menus. The package provides automatic removal of hidden lines, curved-surface modeling, color fill, and walk-through or flyby animated sequences, as well as multiple views, axonometric, orthographic, and exploded views.

Model 357 features a dual color-graphics-monitor configuration. The design monitor provides an uncluttered view of the design in progress; the command monitor can simultaneously display windows for symbol libraries, on-screen symbol selection, and design-calculation routines that you can execute at any time during the drawing process. Model 240, $1250; Model 320, $1950; Model 357 (2-D version), $2750; Model 357 (3-D version), $3950.

Maxam Technologies Inc, 15215 Shady Grove Rd, Rockville, MD 20850. Phone (301) 330-7200.

Circle No 581

You Don't Need a Thousand Words When You Have a Picture Like This!



Unretouched photograph

*3.5 NS max. rise & fall time measured at CRT cathode.

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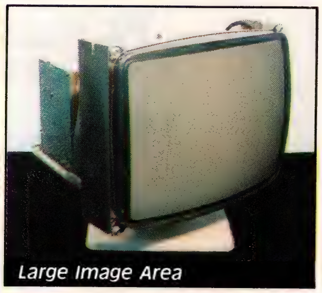
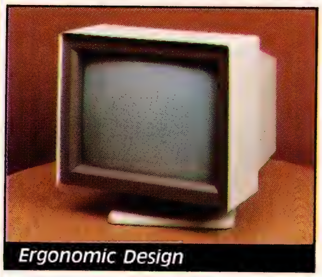


Large Image Area



Ergonomic Design

State-of-the-Art Technology

CIRCLE NO 16

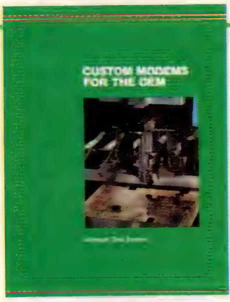
Exotic Customs at UDS

The special requirements of data communications OEMs have resulted in some pretty exotic custom modem cards from Universal Data Systems.

Funny form factors are routine fare for our custom designers. Nooks, crannies and odd card configurations are no problem, given sufficient square inches of real estate. UDS engineers have even designed a circular 212A modem that fits in the back of a residential electric meter.

Non-standard modem functions are another specialty of the house. For example, UDS engineers have already designed and delivered a hand-held RF modem operating at 4800 bps!

UDS has successfully handled more than 3,000 custom OEM modem design assignments — and we can handle yours. To begin an exotic custom, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 205/721-8000; Telex 752602 UDS HTV.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Created by Dayner/Hall, Inc., Winter Park, Florida

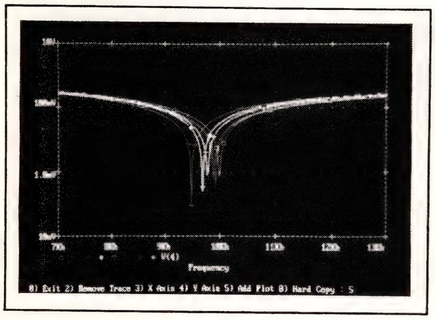
CIRCLE NO 175

CAE SOFTWARE

The CapFast CAE package runs on the IBM PC/AT and compatibles and on Sun workstations. The package includes a symbol editor and a schematic editor, a symbol library of more than 2000 standard parts, a programmable net-list library that combines net lists from individual pages into a net list representing a complete design, interfaces to PSpice and other simulators, and a facility that lets you graph the results of your simulations. In addition, it has interfaces that let you prepare the files resulting from your schematic design for layout by pc-board-layout programs from other vendors. Three versions of CapFast are available: one for a PC/AT equipped with an EGA (from $2600), one for a PC/AT equipped with high-resolution 1024×768-pixel graphics (from $3400), and one for Sun workstations (from $5800).

Phase Three Logic, Box 985, Hillsboro, OR 97123. Phone (503) 640-2422. TLX 469092.

Circle No 583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SIMULATOR FOR SUN

The PSpice analog-circuit simulator, originally introduced for the IBM PC and compatibles, is now available for the Sun workstation family. PSpice runs under the Unix operating system and makes use of the Sun Windows graphics subsystem. You can use the program for dc, ac, and transient analysis. The device models include diodes, bipolar transistors, junction FETs, MOSFETs, GaAs FETs, and nonlinear transformers. The Monte Carlo option lets you perform statistical analysis.

You can assign tolerances to component values and device- or lot-tolerances to device-model parameters. Device tolerances generate variances that are independent from device to device, whereas lot tolerances generate variances that are the same for all devices. The package includes libraries of standard parts, and the Parts option lets you build additional libraries from data-sheet information. The Device Equations option provides partial source code for PSpice and lets you change the built-in device equations or set up equations for a new device. Prices for the Sun version are $1900 for PSpice, $700 each for the Monte Carlo and Device Equations options, and $900 for the Parts option.

MicroSim Corp, 23175 La Cadena Dr, Laguna Hills, CA 92653. Phone (800) 826-8603; in CA, (714) 770-3022. TLX 265154.

Circle No 582

DISK UTILITIES

Survival Kit combines the vendor's DS Recover and DS Backup+ programs in a single package that runs on an IBM PC or compatible machine. DS Backup+ lets you back up a hard disk to any DOS logical device, including another hard disk. If you're backing up to floppy disks, the program estimates the number of disks you'll need and lets you format the floppies, if necessary, before backup starts. You can do a complete backup or restore, or you can do an incremental backup of only those files that have changed since the last backup. You can also select specific files or groups of files (with filename wildcards) for backup.

During the backup process, the program performs sector squeezing to save disk space; you can also request data compression to save even more space. The program periodically tells you what percentage of the backup has been completed and how much of the backup medium has been used. DS Recover protects your files against accidental deletion, and it can even unformat a hard disk to recover deleted files that the program had previously protected. The program includes a snapshot option that periodically writes the entire contents of RAM to disk; the option lets you recover some or all of a file that you've not yet saved. $129.

Design Software Inc, 1275 W Roosevelt Rd, West Chicago, IL 60185. Phone (312) 231-4540.

Circle No 584

PC-BOARD LAYOUT

The EE Designer Layout Module is a pc-board-layout program for users who already have a schematic-capture program, or who need only a layout tool. The program runs on the IBM PC/XT and PC/AT and compatibles. The layout module directly handles schematic files and net lists generated by the vendor's EE Designer and EE Designer II products; if you used Schema or OrCAD to generate your schematics and net lists, the program automatically converts the symbols and lets you edit the conversion tables interactively. Alternatively, you can enter a net list directly from the keyboard.

The program positions components on a 12.5-mil grid, lets you select any of eight trace widths and 10 pad sizes, and handles boards as large as 24×24 in. and having as many as 26 layers. You can generate output files in generic plot (GPLOT) format to generate prototype-quality 2X artwork on an Epson graphics printer. The program also lets you send files to pen plotters and laser printers that use or emulate HGPL commands. An optional Gerber utility lets you generate output files in Gerber format for photoplotting. $695.

Visionics Corp, 343 Gibraltar Dr, Sunnyvale, CA 94089. Phone (408) 745-1551. TLX 346352.

Circle No 585

Don't Buy It – Try It First!

Genesis' Linker & Debuggers for the 8086 Family

Genesis Microsystems has a linker and debugger that engineers can get really excited about.

To begin with, our GeneLink™ linker produces ROMable code from both Microsoft and Intel object modules. It is so fast it can link 51K of code from 24 modules in 5.33 seconds.*

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*Benchmark: Time required to link the GeneScope debugger on a 6 MHz IBM AT.

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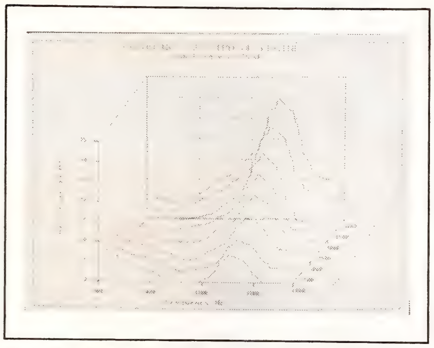
CIRCLE NO 142



DATABASE SOFTWARE

Tekbase is a relational-database management system that's optimized for use by engineers and scientists; it runs on Hewlett-Packard Series 200 and Series 300 computers. The system allows you to establish databases containing large arrays of scientific data in the form of real, complex, and short- or long-integer data. You can also include date, time, Boolean, character, and character-string information in the database. Disk-file, terminal-emulation, and IEEE-488 commands allow you to acquire the data from a variety of mass-storage systems, remote computers, and instrumentation systems. A technical query language similar to IBM's SQL (Structured Query Language) allows you to sort and manipulate the data. You can extend this language by adding optional software modules tailored to specific application areas. You can display the extracted information in a variety of textual and graphical formats. £1750.

Protek, 10 Grosvenor Pl, London SW1X 7HH, UK. Phone 01-245 6844. TLX 263978.

Circle No 590

μP SIMULATORS

This family of 11 simulator-debugger programs runs on IBM PCs and compatibles and allows you to use your PC for all stages of software development for 6300-, 6500-, and 6800-family; 8048; 8051; 8080; 8085; Z80; and NSC800 8-bit μPs. For many applications, you won't need a hardware debugger if you've thoroughly tested and debugged your software with the aid of the appropriate simulator. At each step, the simulators display the contents of all machine registers and flags, as well as the contents of memory referenced by the stack pointer and by index registers. The display shows you the next instruction to be executed, in disassembled form, with its operands. If the instruction references memory or I/O, the display also shows you any data that will be overwritten by the instruction.

After executing each instruction, the program updates a 6-digit machine-cycle counter that provides information valuable in timing analysis; you can reset this counter from the keyboard. You can inspect (and modify from the keyboard) the contents of any machine register, memory location, or I/O buffer. Execution speed varies from 1500 instructions/sec on a standard PC to 10,000 instructions/sec on an 8-MHz PC/AT. Each simulator, $75.

Mecklenburg Engineering, Box 744, Chagrin Falls, OH 44022. Phone (216) 338-1900.

Circle No 586

CELL COMPILER

The Generator Development Tools (GDT) system allows IC designers to build and verify reconfigurable circuit generators (also known as cell compilers or silicon compilers). The latest version of GDT contains major enhancements, including a menu-driven interface that simplifies operation of the system, a new text editor, additional design libraries, and features that let you perform simulations more easily and more quickly.

The menu-driven interface includes context-dependent pop-up menus, which you can bypass once you're familiar with the system. The multiple windows let you edit your design, add system comments, and establish a transaction-history file. The new generator-calling feature lets you call up circuit generators that you've previously stored in a library and incorporate them in a new design, with or without editing of the cell parameters. The enhanced version also offers a new contour-router feature, improvements to the simulator tool, and a new version of GDT's standard Lextract tool. The improvements are shipped without charge to current users of GDT; for new customers, the price of the enhanced GDT system is $49,500 to $88,000, depending on the configuration of the Unix host.

Silicon Compiler Systems Corp, 2045 Hamilton Ave, San Jose, CA 95125. Phone (408) 371-2900.

Circle No 588

PC-ULTRIX BRIDGE

PC-Interface allows users of μCs that run PC-DOS or MS-DOS to have transparent access to programs and data files on VAX and MicroVAX systems that run the Ultrix 1.1/1.2 operating system. The package consists of a server, resident on the Ultrix system, and a bridge program, resident on the PC. The package provides the PC user with Ultrix file access, processor and printer services, network security, and VT-100 terminal-emulation capability. One server can handle multiple PCs. Server, $500; bridge floppy disk, $250.

Locus Computing, 3330 Ocean Park Blvd, Santa Monica, CA 90405. Phone (213) 452-2435. FAX 213-450-1432.

Circle No 587

PATTERN FILLER

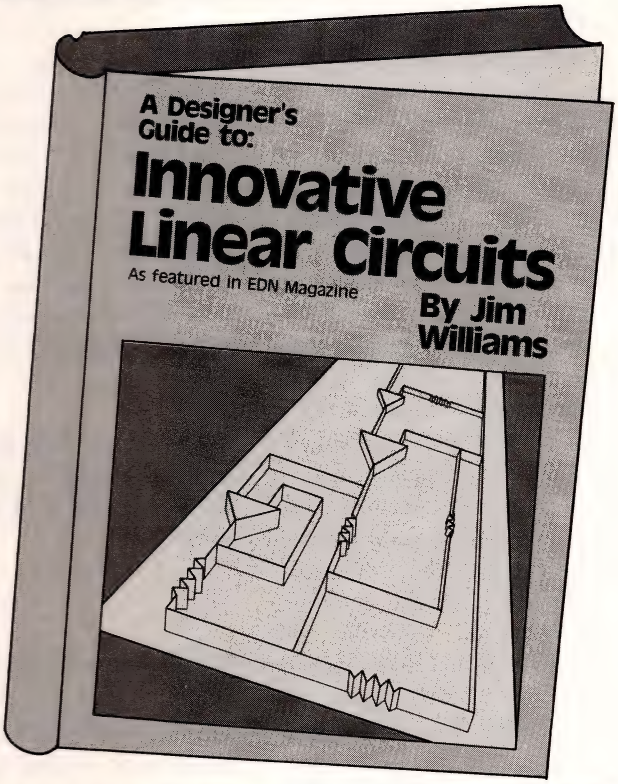
DE-2 (Drafting Enhancements-2) lets you add various crosshatching or solid pattern fills to drawings generated with the vendor's Generic CADD drawing tool. You can select (from a menu) a solid fill or any one of the 24 most commonly used crosshatch patterns, including ANSI patterns. You can also modify the fill patterns provided or create your own custom-designed fill patterns. DE-2 can automatically fill

ANALOG IS ALIVE AND WELL IN:

A Designer's Guide to Innovative Linear Circuits

As exciting as digital technology is, you still need analog circuitry to operate on signals from real-world sources. Now, **EDN** is offering a wealth of analog design information in *A Designer's Guide to Innovative Linear Circuits*.

This 186-page collection of articles was developed by Jim Williams, one of America's foremost linear-circuit designers. It includes practical and efficient ways to use op amps, comparators, data converters, and other analog ICs, and discusses the theories behind all the design techniques presented.



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PUBLISHING SOFTWARE

VAX Document is a publishing-software package for producing complex technical documentation on a VAX/VMS system. Among its key features are a generic mark-up language, a library of book designs, output to laser printers with a variety of serif and sans-serif type fonts, and the ability to merge text and graphics into the laser-printer output file. You can use the vendor's LSE (Language Sensitive Editor) to create documents for formatting by VAX Document, and both programs work well with the vendor's CMS (Code-Management System), which can provide management and control of all the versions and revisions of a document. The software runs on all VAX computers. Prices range from $1350 for a VAXstation 2000 version to $32,400 for a VAX 8800 version.

Digital Equipment Corp, Maynard, MA 01754. Call local sales office.

Circle No 597

LAB SOFTWARE

Targeted for use in laboratories where data from a variety of instrumentation sources requires collating and analyzing, the LAB60 software provides database-management facilities. Running on DEC PDP-11 computers, LAB60 is optimized for use with the company's instrumentation equipment, but can be used with any equipment capable of generating suitable ASCII output. Using the software, you can quickly merge results from various on-line and off-line sources to prepare analytical reports. A layered structure ensures that urgent operations are given priority, and an active database maintains information on data samples of current interest, providing high-speed access to results and immediate indication of data-sample backlogs. Less urgent information is archived for future use.

The package also offers error reporting, fault indication, and help menus. Optional software modules are available for reporting, statistics, quality analysis, and change correction. The software system kernel costs $25,000. Additional software modules are priced between $1500 and $3000.

Philips Industrial & Electroacoustic Systems Div, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

Circle No 591

Philips Test & Measurement Instruments Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 592

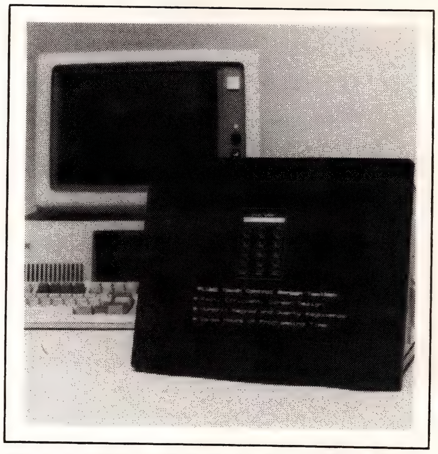
SOFTWARE TOOLS

The Axion suite of software-development tools simplifies software development by automatically generating software documentation and language code. The suite currently includes three tools: Kindra, Asym, and Kalix. Kindra lets you design programs by using graphical notation based on SDL (Specification and Description Language), an international standard. You use a mouse or simple textual descriptions to enter the design. The package then generates design diagrams and codes the application program in C, Pascal, PL/M, Coral, or Chill.

Asym lets you exactly define the way a software system is built from its component modules. Kalix helps you to build design-structure diagrams by allowing you to design, develop, and document software using a top-down, diagrammatic approach. You can generate Pascal or PL/M source code directly from these structure diagrams. Kindra runs on VAX/VMS or VAX/Ultrix and on Unix systems; Asym runs on VAX/VMS systems; Kalix runs on VAX/VMS systems, IBM PCs, and Intel Series III MDS and NDS development systems. Kindra, £2000 to £30,000; Asym, £1300 to £1800; Kalix, £300 to £5000, depending on machine.

Temart, British Telecom Research Laboratories, Martlesham Heath, Ipswich IP5 7RE, UK. Phone (0473) 643690.

Circle No 593



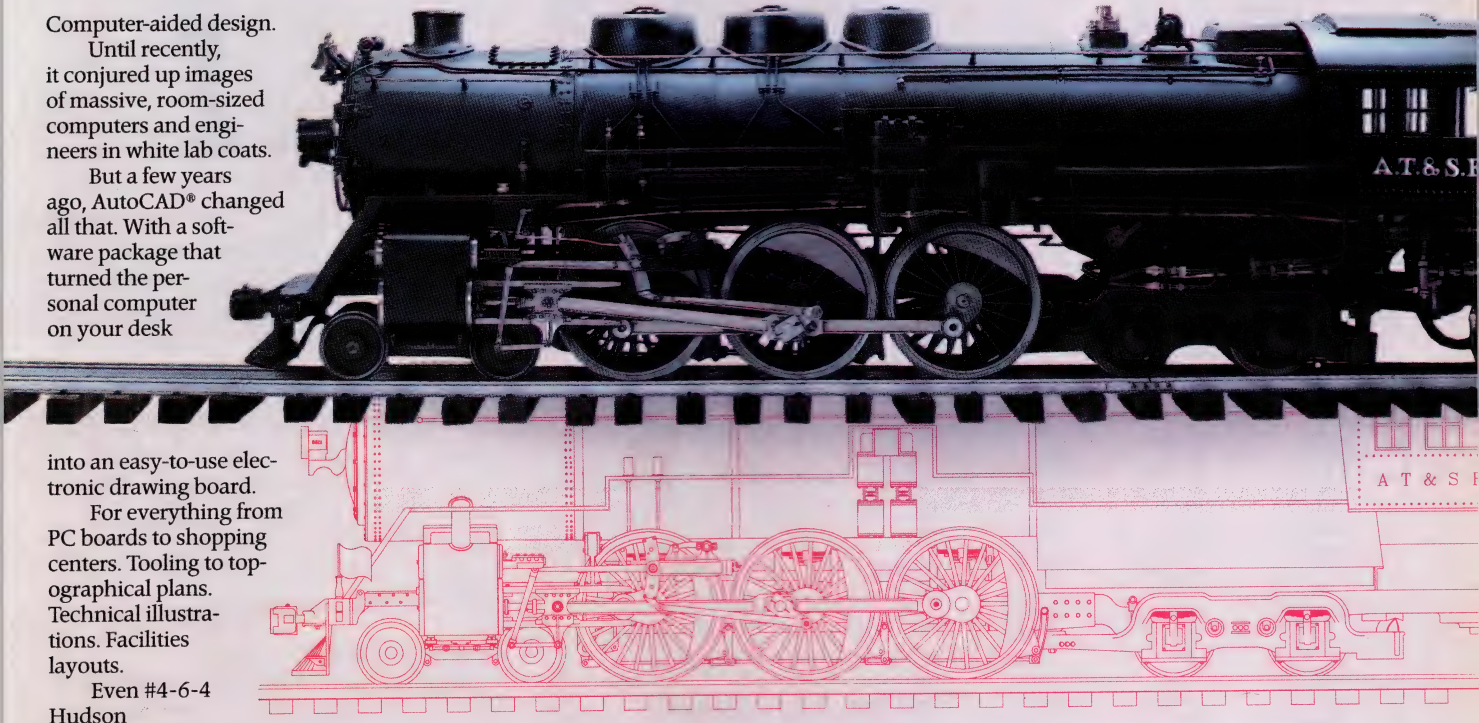
TOUCHSCREEN PACKAGE

TCS Toolbox is a software package that allows you to develop touch displays for the vendor's 1020 Series touchscreen monitors that operate in conjunction with IBM PCs and compatibles. TCS Toolbox contains routines for use with Microsoft's QuickBASIC; these routines let you create and position touchkeys, draw numeric and alphanumeric keypads on the screen for data entry, and process touch inputs. One routine lets you draw a box on the screen by defining the position of the upper left corner and the size of the box; another lets you use a single command to draw a 14-character keypad and define the operations that go with each key. $295.

John Fluke Mfg Co Inc, Box C9090, Everett, WA 98206. Phone (800) 426-0361; in WA, (206) 347-6100. TLX 185102.

Circle No 598

Get on board with AutoCAD® 2.6.



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Introducing AutoCAD 2.6

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Like AutoCAD 3D Level 2 which allows you to generate lines and faces at any angle on a drawing, not just on or parallel to the X-Y plane.

Or associative dimensioning which automatically updates dimensions after you've stretched, scaled, or rotated an object.

And transparent PAN, VIEW, and ZOOM, which you can use while another command is in progress.

The result? A powerful electronic drawing tool that lets you concentrate on the drawing, and not on the electronics.

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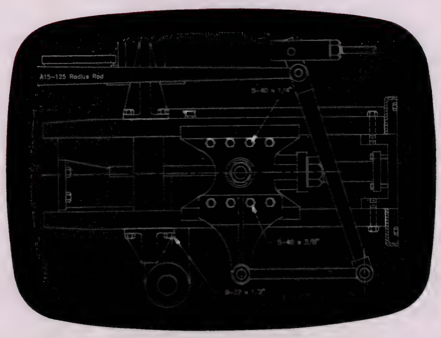

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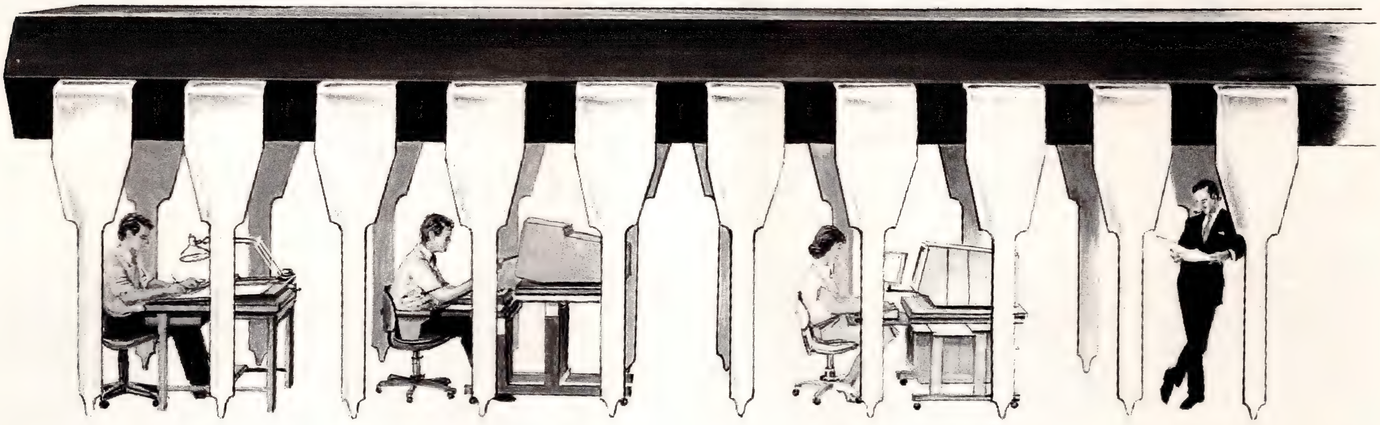

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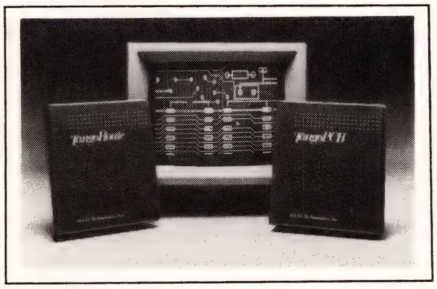
Software

APL FOR MACINTOSH

MacAPL is an APL interpreter that makes full use of the Macintosh computer's architecture. You can use MacAPL's built-in functions to manipulate picture variables in image-processing applications. The package's shared-variable feature allows multiple users to use as many as four workspaces simultaneously on an AppleTalk network with an AppleShare file server; record-locking preserves data integrity. An interface gives you access to ROM toolbox routines and machine code. The representation of real numbers yields 18 digits of precision and allows special values such as infinity. The package includes a run-time version of MacAPL that you can distribute, royalty-free, with application programs that you create, so that customers don't have to purchase the interpreter to run your applications. To run MacAPL, you'll need a standard or enhanced Macintosh 512K, a Macintosh Plus, or a Macintosh SE. $125.

Leptonic Systems Co, 405 Tarrytown Rd, Suite 145, White Plains, NY 10607. Phone (914) 682-0377.

Circle No 596



AUTOROUTER

Tango-Route is a pc-board autorouter that runs on IBM PCs and compatibles. The program can route 4-layer boards (power and ground planes and two signal planes); the boards can be as large as 32×19 in. The autorouter can use both 90 and 45° traces. The program can accept net lists from Schema and OrCAD tools and from the vendor's Tango-PCB schematic-capture program. The program performs 11 routing passes, any of which you can toggle on or off, and it performs route optimizing. According to the vendor, the program will autoroute an IBM PC plug-in board with 90 equivalent ICs in about 20 minutes on an 8-MHz PC/AT. The router achieves 85% completion with a maximum of one via per trace; if you allow two vias per trace, the router achieves 95% completion in about 35 minutes. $495.

Accel Technologies Inc, 7358 Trade St, San Diego, CA 92121. Phone (619) 695-2000.

Circle No 601

LISP DEVELOPMENT

TransLisp Plus provides more than 400 Common Lisp primitives, an interface to the C language, and a variety of debugging tools. An optional run-time version is available. The package runs on an IBM PC or compatible that's equipped with at least 320k bytes of RAM and one 360k-byte floppy-disk drive. It can use as much memory as is available (to 640k bytes max) and will use an 8087 coprocessor if one is present in the system. The interface to Microsoft C makes the program more versatile; you can, for example, write a C program and add it as a new function to the Lisp program. Alternatively, you can add a small amount of Lisp code to an existing C program, or integrate code from C libraries into your Lisp application. You can distribute the optional run-time interpreter together with the programs that you write when using this Lisp software; your written programs thereby become stand-alone software packages.

Debugging tools include a trace facility; a pretty printer that makes your source code easier to read; the Cross Reference package, which shows where variables and functions are stored; Traceback, which steps through a top-level form; and Break, which forces the computer to break out of an infinite loop. You can invoke the fast editor, as well as

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PC,XT,AT: MS-DOS
PowerNode: UTX/32

UNIX: TM of AT&T Bell Labs.
VAX, VMS, PDP-11, ULTRIX: TM of Dig. Equip. Corp.
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DOS commands and applications, from within the program. The run-time version is available separately but requires the parent program. TransLisp Plus, $195; run-time version, $150.

Solution Systems, 335 Washington St, Norwell, MA 02061. Phone (800) 821-2492; in MA, (617) 659-1571.

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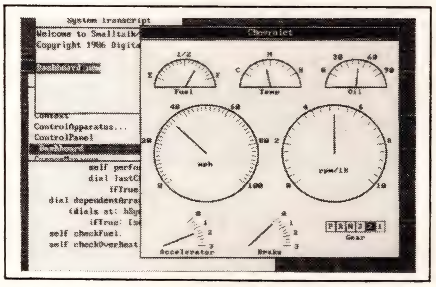

```
Welcome to Smalltalk/
Copyright 1986 Digita
```

```
        self perfo
        dial lastC
           ifTrue
  dial dependentArra
     (dials at: hSy
        ifTrue: [se
  self checkFuel.
  self checkOverheat
```

SMALLTALK FOR PC

Smalltalk/V is a version of the Smalltalk object-oriented programming language that runs on IBM PCs and compatibles. The package features bit-mapped graphics, windows, mouse input, a built-in Prolog compiler, object-swapping virtual memory, and a source-level debugger. It's particularly applicable to software development with AI techniques. You can open multiple windows on the screen, each showing a different activity, so that you can construct, test, debug, and re-execute code without leaving Smalltalk/V. Another feature automatically swaps objects (which may be as simple as an integer or as complex as a compiler) in and out of RAM as needed, so you can build very large programs without exceeding the PC's 640k-byte limit. An automatic change log records every modification you make to your program, and an optional communications interface allows for communication with Unix systems and other systems over an RS-232C link. Smalltalk/V, $99; communications option, $49.

Digitalk Inc, 5200 W Century Blvd, Los Angeles, CA 90045. Phone (213) 645-1082.

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TURN TO PAGE 288

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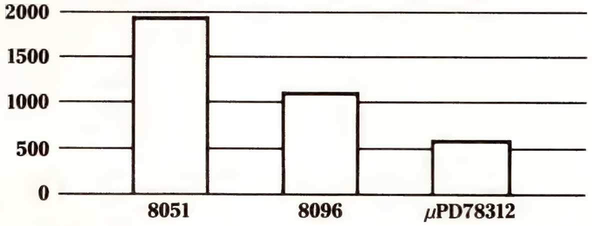

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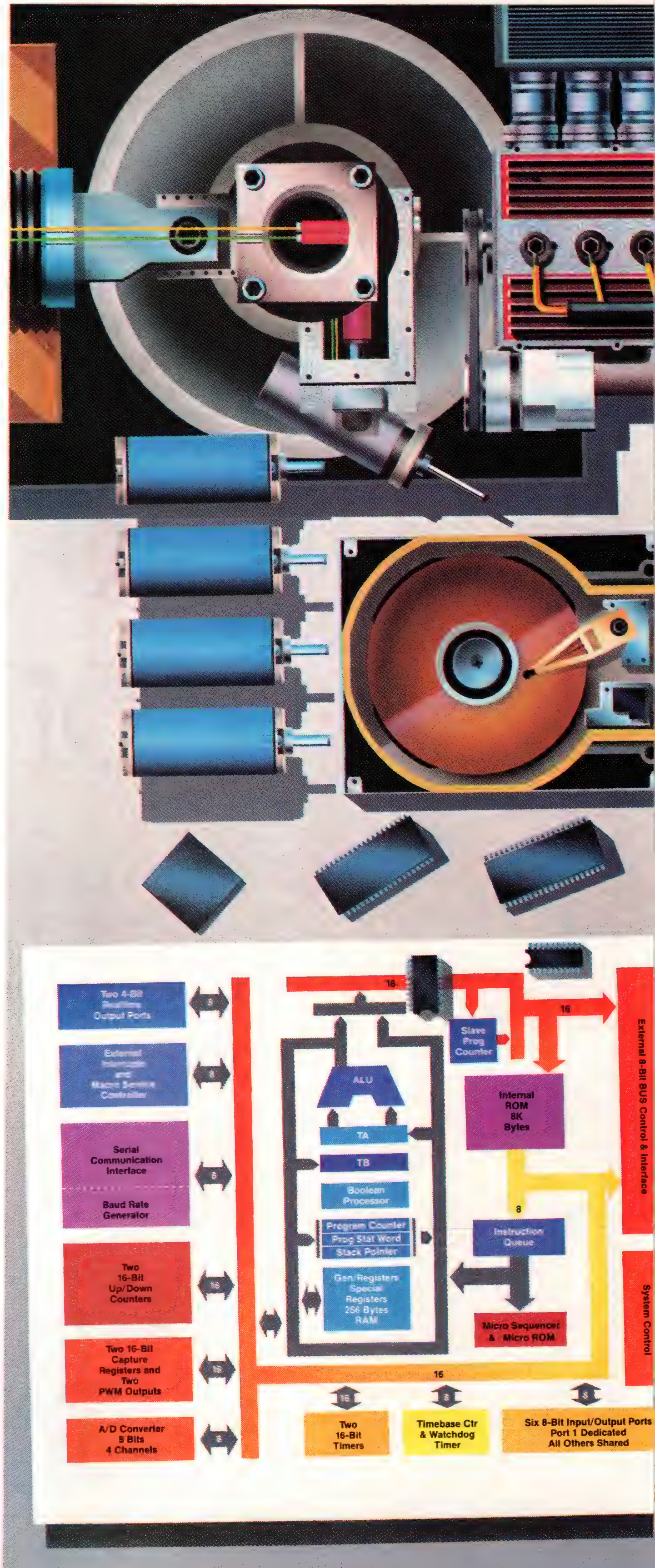
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DATABASE SOFTWARE

The Impulse database-software package allows real-time data acquisition to operate as a background task in an IBM PC/XT or PC/AT. Optimized for use with the company's Imp measurement pods, the software lets you continuously scan as many as 600 measurement channels per sec. The measurement data can be processed and dumped to disk or displayed in real time in either numerical or graphical form. Foreground programs can also access current measurement values.

You can configure the software to provide multiple scan intervals and to detect alarm conditions. Color graphics highlight the alarm conditions. Besides setting simple limit alarms, you can set alarm conditions according to rate of change and deviation from a set point. You can modify system operation without stopping the measurement process. Optional communications software allows two PCs, linked by their serial ports, to share a common database. The basic Impulse software package costs less than £1200. The graphics/alarm option costs £800, and the communications software costs around £1000.

Solartron Instruments, Victoria Rd, Farnborough, Hampshire GU14 7PW, UK. Phone (0252) 544433. TLX 858245.

Circle No 594

Solartron Instruments, 2 Westchester Plaza, Elmsford, NY 10523. Phone (914) 592-9168. TLX 145487.

Circle No 595

IMAGE PROCESSING

ITEX PCplus is a library of image-processing subroutines that run on the IBM PC and compatibles. Release 1.3 of this library has been enhanced with 17 new routines. All the library's routines now run 73% faster than those of previous versions, the vendor claims. The software operates in conjunction with the vendor's PCVisionPlus frame grabber, which is a video-acquisition and -display board that can be used in a wide variety of image-processing applications. The new functions include averaging, subtraction, 3- and 4-point warping, frequency-domain (FFT) filtering, and measurement. All the routines are callable from programs written in C and compiled by the Microsoft and Computer Innovations C compilers. ITEX PCplus, $595; PCVisionPlus Frame Grabber, $1995.

Imaging Technology Inc, 600 W Cummings Park, Woburn, MA 01801. Phone (617) 938-8444. TLX 948263.

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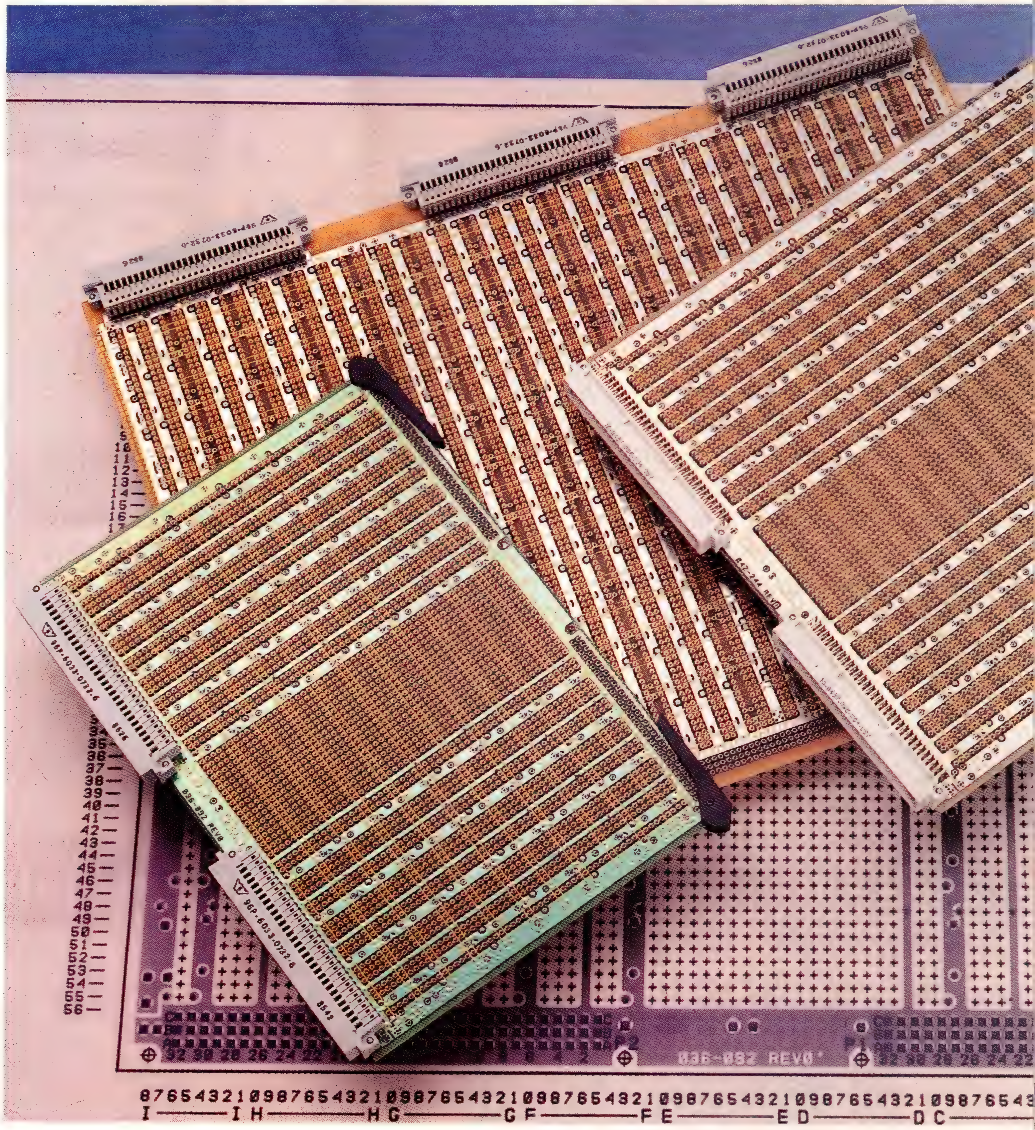
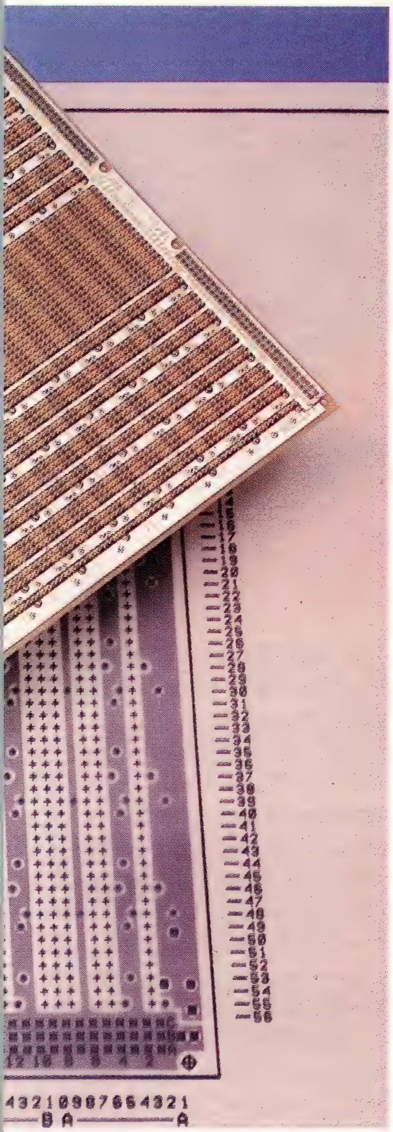


VME Bus panels
(Hybricon Corp)

Dedicated prototype panels simplify bus interfacing tasks

Hardware and Interconnect Devices



Wire-wrapping panels designed to interface with specific bus structures can speed up a product's development time by significantly reducing the prototyping phase of the design cycle.

Tom Ormond, *Senior Editor*

Product development time has always been a problem for system designers, and it is especially so today, given the growing need for high-performance products and the more complex bus architectures. Prototyping panels designed to interface with a variety of specific bus structures can help address these development problems. If you spend too much time in the development phase, the market windows might close before your product is fully tested and available. Some prototyping boards offer you a way to get your product to market as fast as possible—and in a very cost-effective way, too.

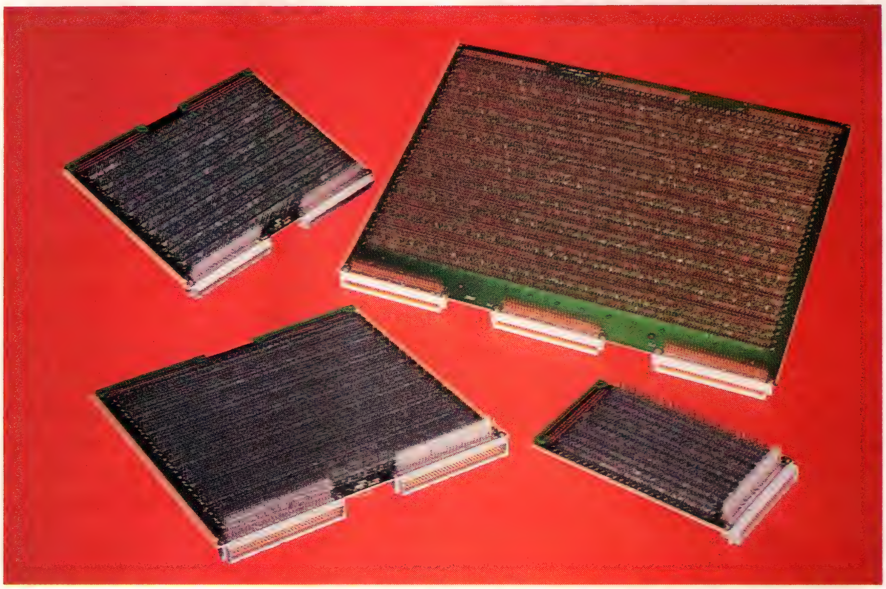
When selecting a prototyping panel for a bus system, you should keep in mind the major criteria, some of which are more obvious than others. Clearly, for example, the board must conform to the mechanical dimension requirements of the bus. And the power and ground commitments from the planes to the backplane connectors must match bus specifications. In addition, the power plane layout should be capable of distributing not only the main power but the auxiliary voltages as well.

Buses such as the VME and Multibus II have mechanical packaging aspects based on the Eurocard standards. It's imperative that cards for these buses conform to the standards to ensure a proper match of the backplane to card cage and to accommodate the Eurocard-style front panels used in many applications.

Other panel attributes are not so obvious. For example, packing density requirements can be extremely high. The boards specified for both VME and Multibus II are quite small and rely on the extensive use of LSI devices. Despite the large number of LSI devices available today, designers still must often deviate from a bus standard and go to larger boards. Thus, the panel's pin configuration is extremely important.

The complexity of LSI chips makes the low impedance of a panel's bypassing techniques very important. Traditional bypassing techniques (such as locating capacitors between the power and ground planes) often prove inadequate because the residual inductance of the wired connection between the ICs power and ground pins can develop crosstalk signals that are then common to all circuits within the LSI package. To avoid this problem most effectively, use a panel that has provisions for bypassing chips on an individual basis.

When you're building prototypes for some of the more advanced buses, bypassing and the routing of connections from the driver to the bus are even more critical. In these cases, the circuits must be able to draw current from the bypass capacitors instantly. The ability to satisfy this need while



VME Bus panels *(Garry Electronics)*

also providing short, direct interconnects from the drivers/receivers to the bus connector determines whether you'll be able to use a panel in a particular application.

In configurations involving high-density boards and their complicated layout requirements and interconnect routing, wire wrapping has the edge over other techniques because the CAD systems now available have very sophisticated methods for routing the wiring, determining the wiring sequence, minimizing wire run lengths, and detecting and correcting errors. One final consideration involves the high density so prevalent today. Selecting a board that eliminates unused pins can be a real plus. You'll find that board is much easier to work with and debug.

The variety of boards available can also pose some subtle problems. The Eurocard specification enumerates a series of board sizes, and designers working with the Multibus II or VME Buses take advantage of the range of options. Often they use boards larger than what's considered standard for a given bus. The deviation, however, lets them develop more effective function groupings. The VME Bus specification calls for a board that is 6U high by 150 mm. (One U equals 1.75 in., which is a standard height increment for 19-in. rack systems.) But a number of other board sizes are popular: 6U by 280 mm, 9U by 160 mm, 9U by 220 mm, 9U by 280 mm, and 9U by 400 mm.

If you select one of the larger boards for your prototyping project, you must make sure the manufacturers have designed the power-distribution and ground planes properly. Distributing the main power through one or two plane layers and then connecting the auxiliary voltages from one or two central points with long wires makes little sense. Thus, for example, the 9U×280-mm board should have at least four layers and be able to effectively distribute and bypass auxiliary voltages as well as the main power voltage.

The assignment order of the P1 and P2 connectors is another selection consideration peculiar to 9U boards. The P1 and P2 are the connectors that interface with the main J1 backplane and the 32-bit J2 extension backplane. The VME spec for a 6U board places the J1 backplane at the top and the J2 at the bottom. Two options are possible for the 9U board's 3-connector configuration. In one case, you locate the board's P1 connector at the top and the P2 connector below it (in the middle). The board's unspecified P3 connector is then at the bottom. In the second option, you situate the P1 connector in the center position, the P2 at the bottom, and the P3 at the top. In the board selection process, make sure that the power input commitments agree with the configuration you're going to use.

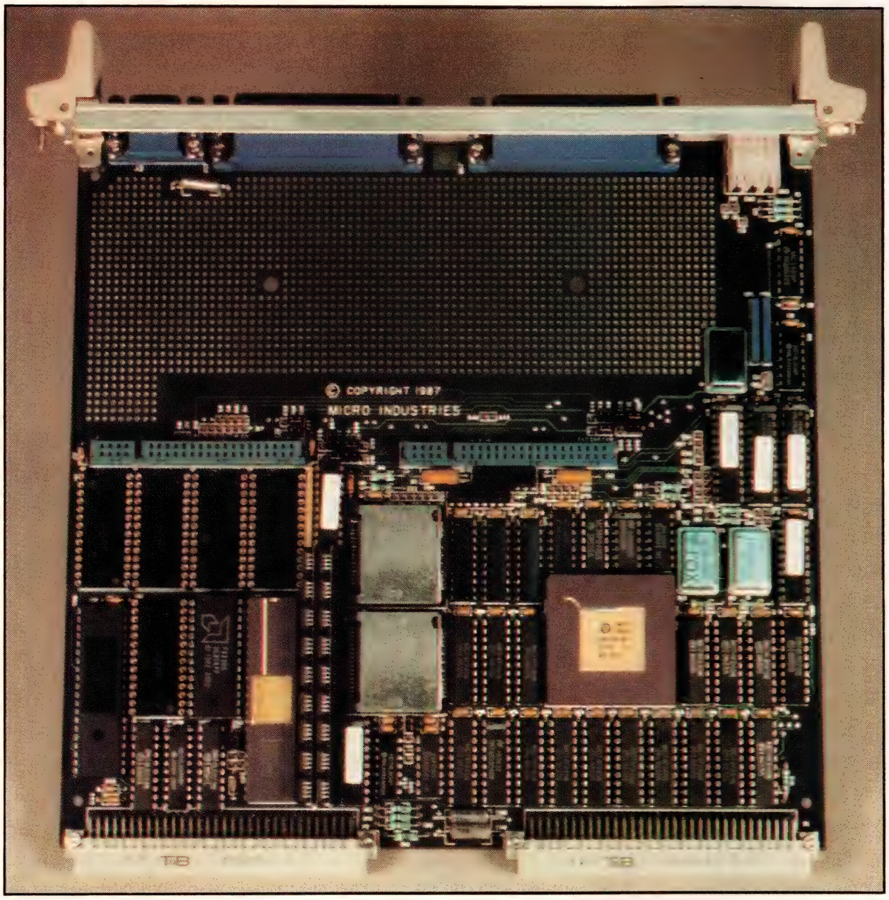
High-density applications combine with variations in bus requirements and board features to often present some knotty selection problems in choosing prototype boards. Using all these criteria ensures that you can find the panels that best work for your specific needs.

Interfacing with the Eurocard format

Vector's Eurocard prototyping boards are aimed primarily at VME and Multibus II applications. They feature a hole pattern that can accommodate any IC on a 0.1×0.1-in. grid in either vertical or horizontal orientation. Twelve different models are available, ranging in sizes from 160 mm by 3U to 400 mm by 9U.

All cards are organized into three areas—the bus-connector area, an I/O area, and a signal-pattern area. The bus-connector area accepts right-angle, 96-pin wire-wrappable connectors. Using them, you can make

If you spend too much time in the development phase, the market windows might close before your product is fully tested and available.



Multibus II development kit
(Micro Industries)

direct connections to power and ground planes with the help of wire or eyelets specifically designed for and supplied with each board. The I/O area will accommodate D-subminiature and 0.2×1.0-in. flat ribbon-cable connectors.

Using eyelets to connect the connector's power and ground pins is a novel feature of these boards. You can use the same type of eyelet to connect to power and ground foils anywhere on the board surface. Individual holes in the power and ground foils have isolating rings around them that prevent inserted leads from shorting.

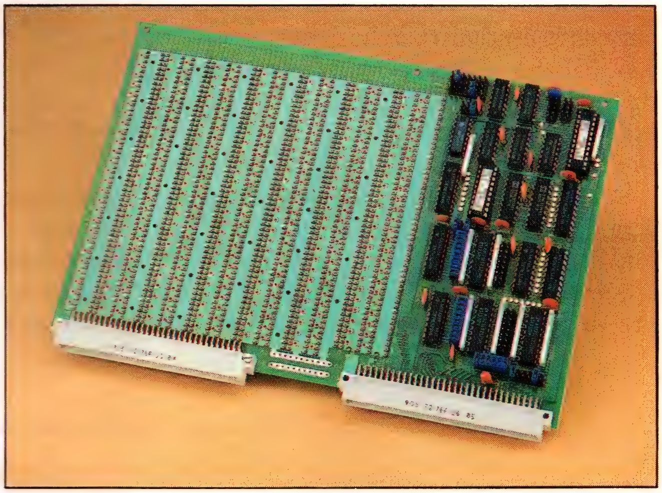
Three signal-area patterns for the board are available: the pad-per-hole pattern with holes drilled on a 0.1-in. grid, plated-thru with a pad on both sides of the board; a buses-only pattern with power and ground buses following the perimeter of the card and holes drilled on a 0.1-in. grid; and the power- and ground-plane pattern, which has one side of the board covered with a ground plane and the other covered with a power plane. Prices range from $15 to $39.

Garry Electronics offers prototyping boards in a variety of VME Bus configurations. Designed to conform fully to bus specifications, they join the packaging ease of pluggable assemblies with the field versatility of wire wrapping.

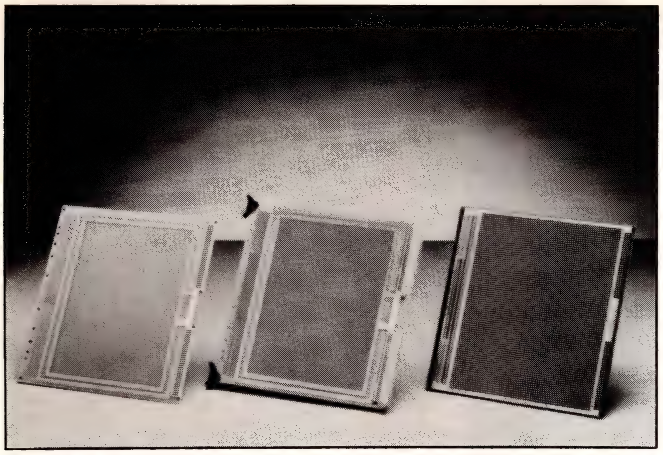
To satisfy virtually any VME Bus system application, the boards are available in four basic sizes—standard, half wide, double wide, and double wide and double high. They are also available in a variety of pin configurations that have room for as many as 252 IC devices.

As other options, Garry offers these boards with 1-, 2-, or 3-level wire-wrapping posts and with hole patterns either perpendicular to or parallel to the I/O rows. Standard boards accommodate 0.8-in. board-to-board spacings, but versions are available for 0.7-in. board spacings to allow even more board density in racks and enclosures. A standard board costs $250.

The $456 Model 12360 VME prototype panel from Scanbe offers the clean appearance of a double-width Eurocard front panel and the convenience of E-Z-ject ejectors. This 6U-size card comes with bypass and decoupling capacitors as well as the VME-specified connected power and ground pins on P1 and P2. The versatile pin layout provides 54 dedicated locations for



VME panel *(BICC-Vero Electronics Inc)*



Multibus II panels *(Vector Electronic Co)*

14-, 16-, 18-, or 20-pin DIP ICs, plus a universal area of 13 columns by 46 rows for larger ICs, SIPs, and other devices. The power and ground planes improve dc-noise margins and transmission characteristics.

The board's terminals can accept two levels of wire wrapping. Panel contacts feature a tapered-entry design to facilitate component-lead insertion. The inner contact (beryllium copper with gold plating) has a 4-finger, closed-entry design, and the outer shell is precision-machined for interconnect reliability. The boards feature 54 capacitors for bypassing (0.01 μF±10% rated for 50V dc), and 24 decoupling capacitors (3.3 μF±10%, 15V dc tantalums). The double-width (1.6-in.) front panel can hold a second wire-wrapping card. The E-Z-ject handles simplify the task of extracting cards (an ordinary 6U VME panel can require as much as 24 lbs of extraction force).

Interfacing with VME Bus

To help designers interface with the VME Bus, Electronic Molding Corp offers prototype panels in 3U single size (Series 10), 6U double size (Series 20), and 9U triple size (Series 30). All incorporate dedicated I/O connectors. Their dimensions comply with standard VME specifications. The 3U and 6U boards are also available with a universal PGA section ($285 for a 6U panel).

All panels are available with a high-density universal pin configuration that has room for ICs having 0.3-, 0.4-, 0.6-, and 0.9-in. center-to-center pin spacings. The three models in the VME 10 Series have an IC capacity ranging from 42 to 73. Series 20 and 30 panels will hold 90 to 223 and 148 to 270 ICs, respectively.

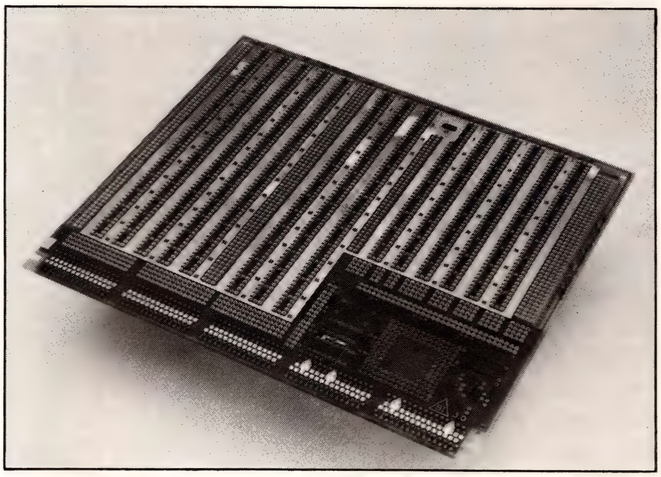
Designed for use with automatic wire-wrapping equipment, all panels feature 96-pin DIN 41612 connectors having gold-plated contact areas. The basic boards are designed for TTL, but multilayer Schottky panels are available for high-speed applications. You can choose V_{CC} and ground terminations from three pin types: socket pins with inner clips, hollow pins (no clips) that allow for the installation of decoupling capacitors, or solid nail-head pins.

Hybricon's VHF Series panels are designed for the VME Bus and are available in high-density (HD) and ultrahigh-density (UHD) terminal patterns. The standard 6U×160-mm board includes provisions for mounting PGAs. In addition to main power planes, all panels have buses for +12 and −12V.

Panels are available in all standard sizes, ranging to a 6-layer 9U×400-mm version. The 9U boards are available in 4-layer versions in 160, 220, and 280-mm depths and in lower-cost double-sided versions. Many are available with the two basic connector arrangements. All panels are designed to accommodate both connected bypassing (power plane to ground plane) and individual bypassing of critical devices. The individual bypassing technique ensures very low residual inductance in the bypass loop.

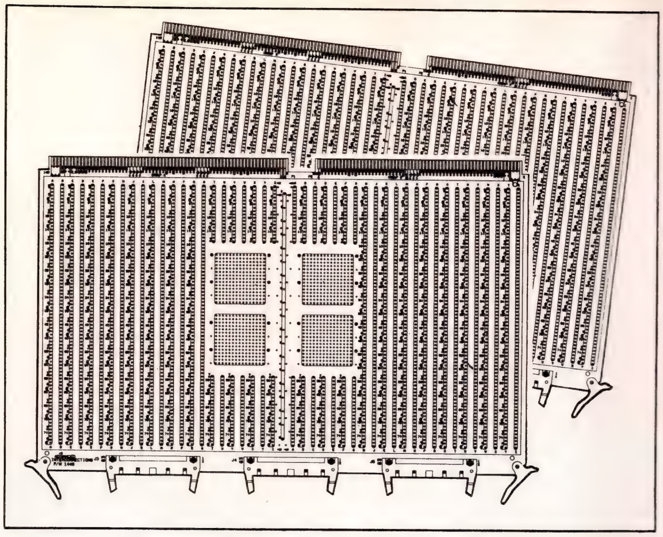
Help's available for computer interfaces

Augat, Vector, Methode, and Advanced Interconnections all offer panels designed for computer buses. Augat's wire-wrapping panels make it easy to create prototype options for DEC's VAX 8200, 8300, and 8800 computer systems. Based on the VAXB1 32-bit high-



VAXBI bus panel *(Augat Inc)*

You should evaluate a number of important criteria before selecting a prototyping panel for a bus system.



***Versabus panel** (Advanced Interconnections Corp)*

performance bus structure, these panels let you rapidly verify logic designs and thereby minimize product development cycles.

To guarantee the signal integrity and the electrical characteristics of the interconnection, these panels incorporate the intricate VAXB1 interface corner. The layout artwork for the corner reflects the latest DEC design revision. The design includes a PGA footprint for the VAXB1 interface chip and sockets for the custom clock and the discrete devices. The panels also contain a logic field that can handle as many as 96 16-pin ICs. A variety of component spacing patterns provides maximum flexibility in board design. Decoupling capacitors located adjacent to every other row further enhance layout flexibility. Panel I/O provides 180 user-defined zero-insertion-force interconnections to the backplane, and reserves 120 ports for bus functions.

All these prototyping panels feature a 10-layer construction—four signal layers, three power-distribution layers, and three ground layers. The panels use machined contacts throughout. Augat's patented 2-piece, tapered-entry socket features a 4-leaf, closed-entry inner contact and a machined outer sleeve (both contact and sleeve are available with either gold or tin plating). The PGA sockets use Holtite contacts. A panel with 2-level wire-wrapping pins and sockets with gold-plated contacts and tin-plated sleeves costs $895.

To let you achieve higher performance when building circuits using 8- and 16-bit μC chips, Vector offers a line of prototyping cards (from $42.30) with a new circuit pattern. The circuitry, called the voltage/ground-plane series, is etched onto 1/16-in. FR4 epoxy-glass circuit boards that have an overall pattern of 0.055-in. holes spaced on a 0.1×0.1-in. grid. Compatible with IBM's PC, PC/XT, and PC/AT computers, full-size boards measure 13.25-in. wide by 4.2-in. (PC and PC/XT versions) or 4.8-in. (PC/AT version) high.

Although an overall copper ground plane is excellent for reducing transients and lowering crosstalk, it can pose problems. To install component leads, socket contacts, or terminals, you need to use special insulating washers or copper-removing tools to insulate the lead from the copper plane. In the voltage/ground-plane series boards, all drilled holes in the copper planes are isolated on both sides of the board by etched copper-free rings that surround each hole.

Two methods are available when you must make a connection to the copper plane. One technique utilizes a custom eyelet that you place in the hole in question. After inserting the component or DIP socket lead, you simply apply solder and allow the eyelet's flange to make contact with the copper plane. The eyelet is flanged on only one side so you connect to only one side of the board. If you use the second method, you install socket pins having solder washers that make contact with one board plane. These voltage/ground-plane boards are also available in a half-width version that measures 5.5 in. wide for the IBM PC/XT or equivalent compatibles.

If you're working with Motorola's Versabus, Advanced Interconnections offers prototyping panels that will ease your design task. The line includes units with standard IC footprints and units that also feature universal PGA footprints.

The standard Versabus panels have a standard logic pattern of two groups of 26 columns containing 77 pins per column; each holds 176 16-pin DIPs. The PGA panels have patterns for 15×15-pin PGA devices as well as standard universal patterns of 32 columns of 77 pins, 7 columns of 20 pins, and 7 columns of 17 pins that accommodate 152 16-pin DIP ICs. The PGA areas are populated with low-insertion-force (2.5 oz average) wire-wrapping terminals.

The standard universal pattern of the Versabus boards has room for ICs with 0.3-, 0.6-, and 0.9-in. pin spacings. The boards are constructed with exposed solder between insulated terminals to allow users to randomly connect pins to V_{CC} and ground. The panels are available with either 2- or 3-level wire-wrapping terminals, which have either gold/tin or gold/gold plating. Both panel versions provide three 40-pin connectors for I/O service.

Methode's Series 300 wire-wrapping panels (from $800) are also designed to interface with the Versabus. The boards have an IC field that consists of 55 columns of 53 pins each and that has a capacity of 120 16-pin devices. An additional five columns with terminals spaced on 0.6-in centers can hold another 42 ICs. In addition, the panels have two sockets that accept 68-pin JEDEC type-A chip carriers.

The panels have two edge connectors for I/O serv-

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For more information . . .

For more information on the prototyping panels discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

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Micro Industries
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Scanbe
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Circle No 557

Vector Electronic Co
Box 4336
Sylmar, CA 91342
(818) 365-5718
Circle No 558

ice—a dual 60-pin connector and a dual 70-pin connector, both with contacts on 0.1-in. centers. For additional I/O, two 50-pin right-angle wire-wrappable headers and two 40-pin right-angle wire-wrappable headers with alternating ground contacts are provided. The panels feature an integral board stiffener and have a common ground plane on both sides in the socket area. They have 39 decoupling-capacitor locations and are available with terminals that will accept either 2- or 3-level wraps.

All these panels can simplify prototyping work considerably. However, two products are available that offer designers a good deal more. BICC-Vero's VME6159 sells for $650 and is a dual-height VME Bus-compatible wire-wrapping prototype panel. It has approximately 30 in^2 of prototype area populated with wire-wrappable terminals. The balance of the panel area contains circuitry for controlling two separate interrupt-request levels and buffering the VME control signals, address lines, and data lines.

The P1 connector on the VME6195 provides all 23 address lines, all 16 bidirectional data lines, all six address-modifier lines, all seven interrupt-request lines, and all pertinent slave-control lines. In accordance with the VME specification, this board is classified as an A24:D16 slave, with an interrupter option of any two of seven. Thus, you can decode any of the address lines, drive any of the lines on the bus, and generate as many as two interrupts.

Onboard signals, such as Board Enable and Board Select, provide one level of device selection. To generate multiple selects, you can combine your own address decoding logic with these signals. A variable-length DTACK delay (from 0 to 500 nsec) increases panel flexibility by allowing you to use slower devices in the prototype area of the board.

The board features two independent edge-triggered interrupts. A falling-edge signal on either of these interrupt-request inputs will generate a complete interrupt request and interrupt-acknowledge cycle. Hardware on the 6159 responds with the 8-bit vector and completes the acknowledge cycle. Because this board is considered a slave on the VME Bus, it cannot assume ownership of the bus or become the bus master.

Micro Industries makes it about as simple as possible to develop products for the Multibus II environment. It offers a development kit for $2000 that consists of an intelligent I/O development board—the MIB II 186/110—and the full software support for specific functions required in a Multibus II system.

The MIB II 186/110 board provides a general-purpose, intelligent interface to the Multibus II parallel system bus (iPSB). It consists of an 80186 μP, an independent configuration processor, as much as 250k bytes of EPROM, a maximum of 512k bytes of dynamic memory, an 82258 advanced DMA controller, an 8259 interrupt controller, one serial communications port, and a prototyping area that is approximately one-third the size of the board and has access to the local μP bus. The serial communications port provides direct access to the board for software development independent of the iPSB.

The board's independent configuration processor gives you a backup indication of how all parts of the board are functioning. What's more, the board can test itself. With this combination, designers can concentrate on developing their application software instead of spending time on bus-testing overhead.

The software support includes the mSDM-186 monitor/debugger and a debugging monitor that's fully compatible with Intel's iSDM-86 monitor/debugger. The mSDM-186 is a set of firmware that lets you inexpensively design and debug application hardware and software by eliminating the need for emulation equipment. You can perform this design and development work on either an Intel Series II or IV development system or on a standard RS-232C terminal. **EDN**

Article Interest Quotient (Circle One)
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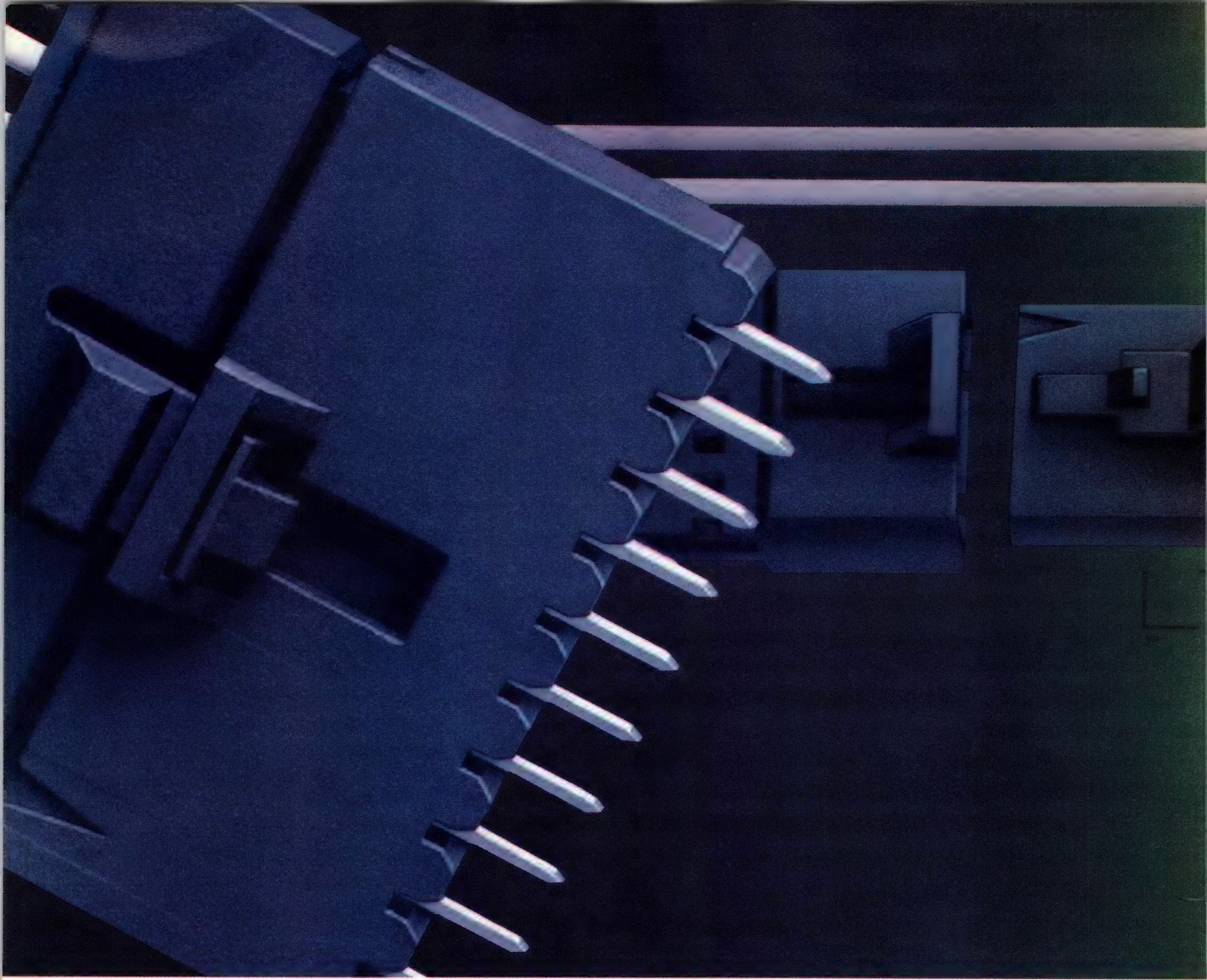

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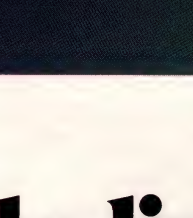

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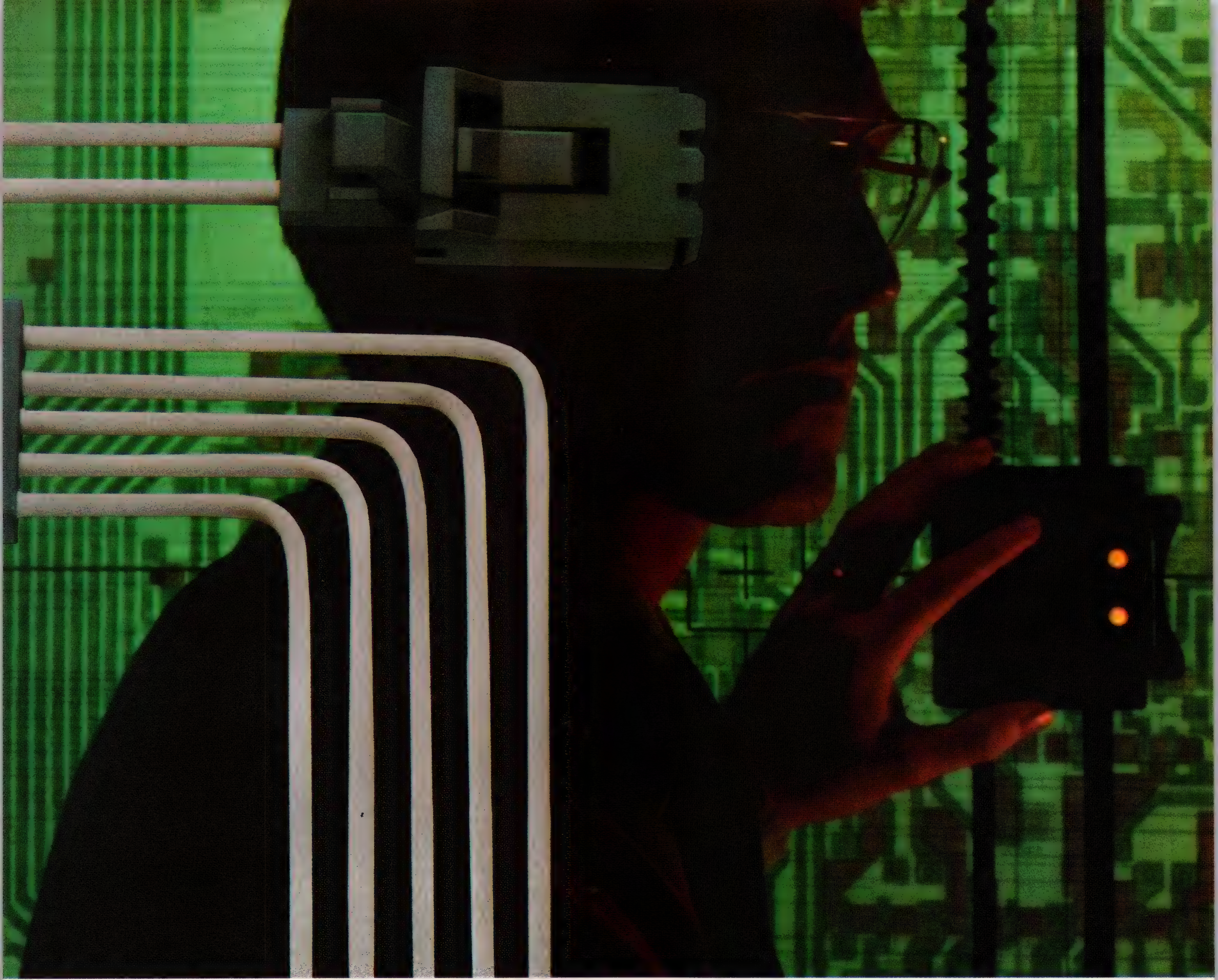

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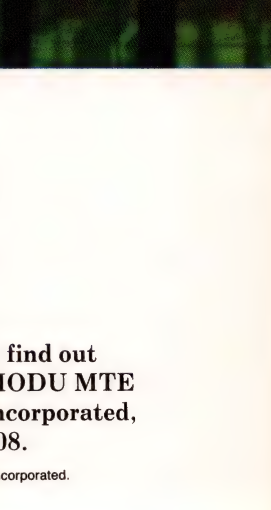

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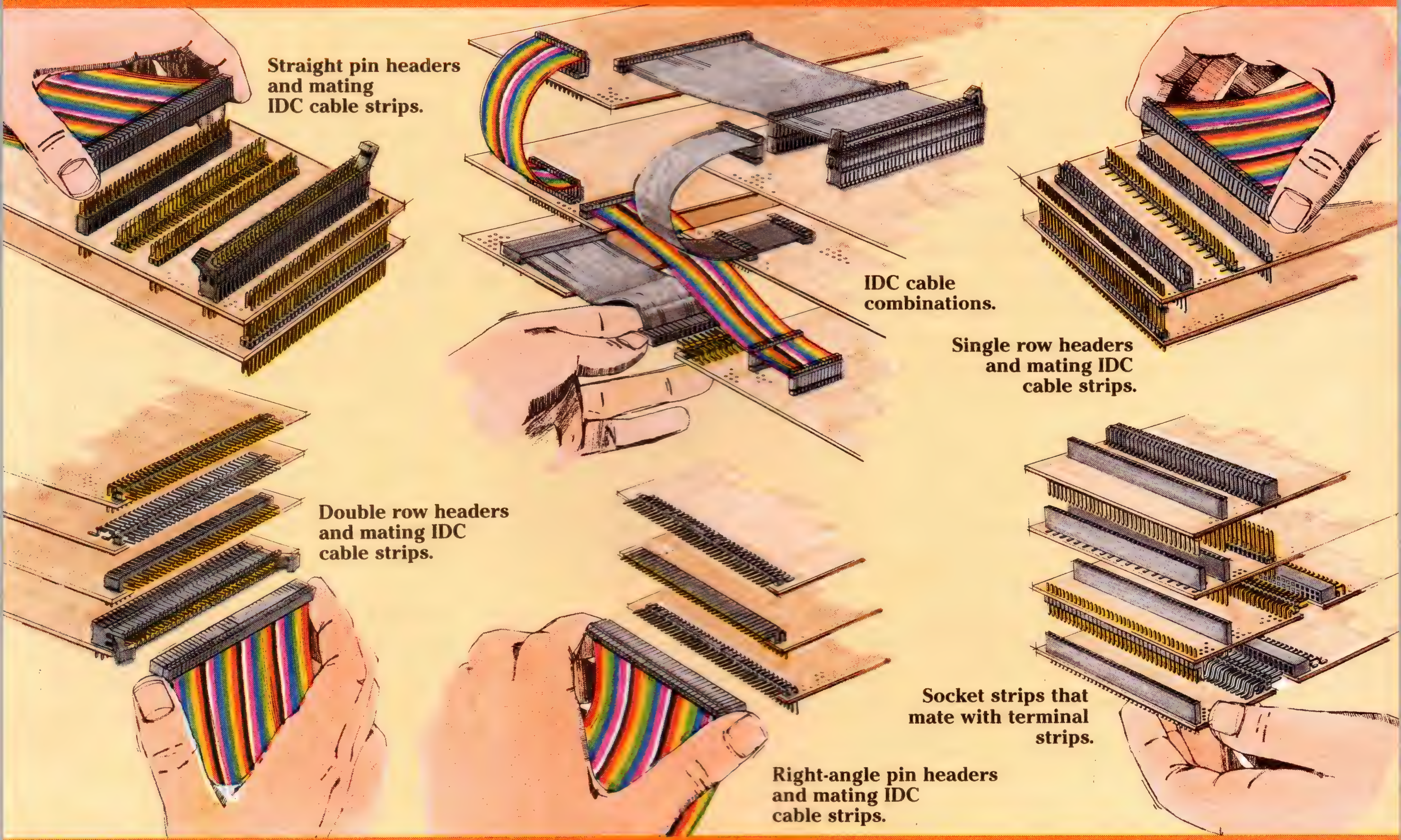
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Surface-mount cabinet cooler solves installation problems, offers flexibility

The CC600F surface-mount compact cabinet cooler is designed for those sealed-enclosure cooling applications where there is insufficient space inside the enclosure to install a cooler. This cabinet cooler is a simple air-to-air heat exchanger and fits outside of the enclosure. It measures 30×7½×4 in., has a 30×8¾-in. flange, and weighs only 14 lbs.

Heat-pipe cores remove heat from inside the enclosure. During operation, a fan inside the cabinet blows air toward the heat-pipe cores, and an outside fan blows air away from them. Inside the heat-pipe core, heat transfer occurs by means of the phase change of a fluid—from liquid to vapor and then from vapor back to liquid. The fluid and a wick are enclosed in a thin-skinned cylindrical copper shell.

As heat reaches the evaporator section of the pipe inside the cooler, the fluid becomes a vapor and travels to the outside, or condenser section. As the vapor condenses, it gives up its latent heat. Now back in a liquid state, the fluid returns to the evaporator end of the heat pipe via capillary action along the pipe's wick-lined walls, to be heated and vaporized again, continuing the heat-transfer cycle.

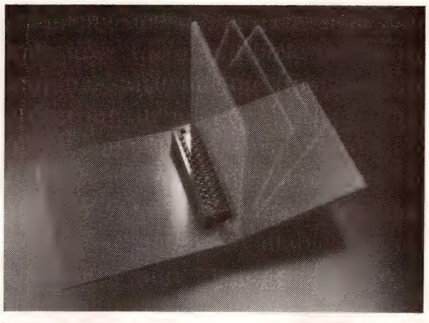
Fin arrays and the two fans augment the heat-pipe action by improving air-to-pipe heat transfer and air flow. Because the fans are the only moving parts, the cooler's power requirement is only 60W. You can specify the CC600F in a new design, or you can retrofit it in the field. Estimated field installation time is one to two hours. The cost is $795.

Noren Products Inc, 1010 O'Brien Dr, Menlo Park, CA 94025. Phone (415) 322-9500. TLX 171410.

Circle No 529

Hinged connector permits repositioning of pc boards without requiring power shutdown

The Hinge connector enables a user to reposition two interconnected pc boards and gain access to hidden points that need adjustment without having to shut off the power. If you mate two boards, you can position them at any angle to 90 degrees. If you use three boards in a "U" shape, you can achieve a more efficient configuration. To disconnect the boards, you simply rotate one board beyond 90 degrees.



The connector is available preassembled or as separate tab and receptacle assemblies. The tab and receptacle connector halves mount on the pc board and mate together in a right-angle position. The tab contacts are tin-plated brass; the receptacle contacts are tin-plated phosphor bronze. The connector housing's material is molded from 6/6 blue nylon and has a UL 94V-0 rating. When mounted on a pc board in a right-angle configuration, the connector measures 0.256×0.288 in. Contact center-line pitch is on 0.079-in. centers.

You can choose from connectors with 4, 6, 8, 10, 12, 15, 18, or 22 positions. PC boards can range in thickness from 0.031. to 0.063 in. The connector is suited to such applications as videotape recorders, TVs, copying machines, and typewriters. It costs $0.03 to $0.04 (OEM qty). Delivery, six to eight weeks ARO.

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EDN NEWS

BRIEFINGS

CareerNews

Digitizer samples at 1 GHz

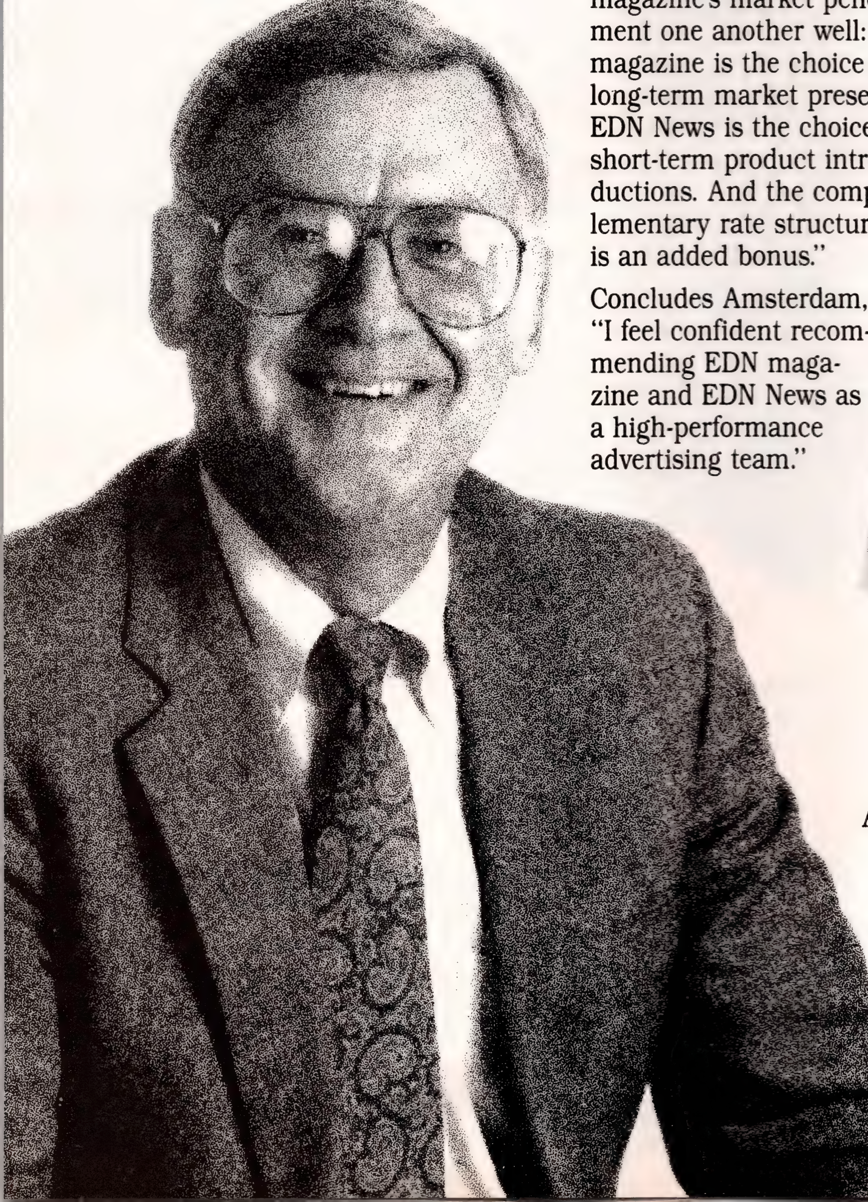
Uses hybrid technology, parallel architecture

Molded boards struggle with custom image

Action in processes and service as board makers look to 3-D applications

Flat mask enhances CRT

Improves brightness, contrast, resolution



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EDN NEWS

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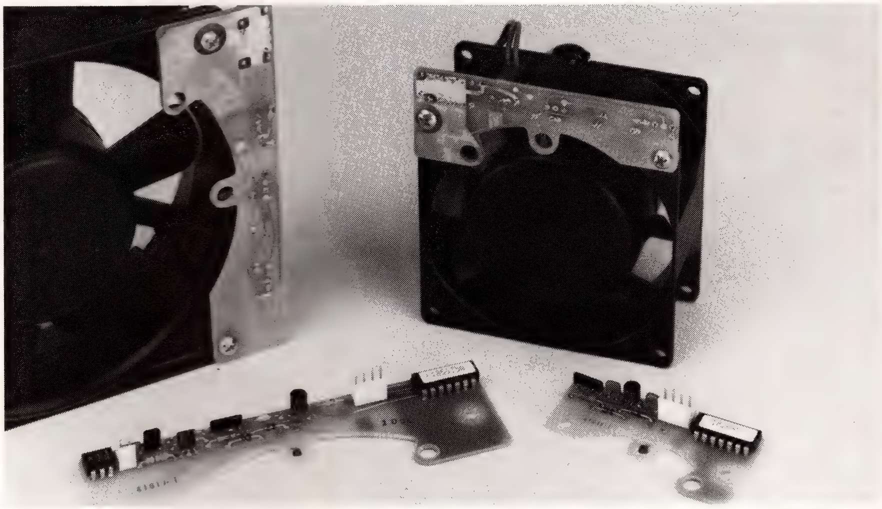
500 Chesterfield Center
Suite 200
St. Louis, MO 63017
314-532-3505 / Telex: 44-7455

CIRCLE NO 173

Self-contained speed controller allows dc fans to idle at ½ rated speed



The PC-DC is a speed controller that mounts directly on a small dc fan operating in a draw-through mode. The controller has a built-in sensor that continually monitors the temperature of the internal equipment, permitting the fan to idle at about ½ speed under typical conditions and substantially reducing excessive fan noise (typically 12 to 15 dB).

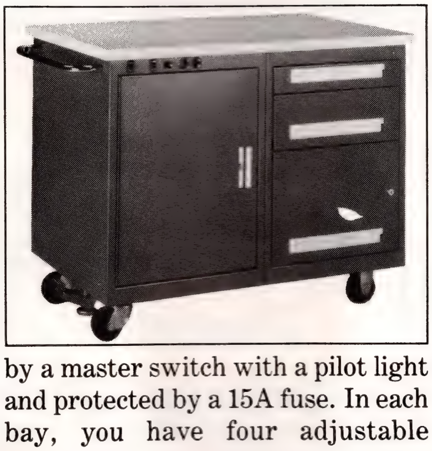
With this type of speed controller, a designer can select a fan for worst-case conditions of ambient temperature, equipment power dissipation, system resistance, and altitude even if he'll seldom be using the equipment under such conditions. The PC-DC will adjust fan speed as necessary to hold the temperature at its sensor position nearly constant. A fan will reach full rated speed when the sensor temperature reaches the chosen full temperature rating (35, 40, 45, or 50°C). The controller also includes a temperature alarm, which triggers at 10°C above the chosen full-speed temperature.

The PC-DC is available in various sizes for direct mounting on square-frame fans ranging from 2⅜ to 4¹¹⁄₁₆ in. You can use it with any supply voltages from 12 to 26V. The controller is self-contained, including the sensor, and adds less than ⅛ in. to fan thickness. No settings or adjustments are necessary. Power connections require an AMP MTA-type header with 0.100-in. spacings. A sample PC-DC kit is available for $34.80.

Control Resources Inc, Smart Fan Div, Box 315, Harvard, MA 01451. Phone (617) 456-8763.

Circle No 531

Versatile mobile test cart can function as a test station or a workstation



This test cart functions equally well as a portable test station, a movable workstation, or a handy conveyance for electronic equipment. Fabricated of 14-gauge steel, the cart rides on two fixed and two swivel casters and features a foot-operated lock for stability. Each cart has a twist-lock receptacle on its frame with a removable 20-foot 14-gauge/3-wire power cord.

The cart comes as either a 1- or 2-bay unit. Each bay has two grounded duplex outlets controlled by a master switch with a pilot light and protected by a 15A fuse. In each bay, you have four adjustable mounting-angle brackets with EIA hole spacings of 0.281 in. You can use the available vertical panel space of 24½ in. to tailor the cart for specific uses.

Carts come in various sizes and are available in 10 standard textured finishes. Prices start at approximately $800. Delivery, four to six weeks ARO.

Cabtron Systems Inc, 200 Anets Dr, Northbrook, IL 60062. Phone (312) 498-6090.

Circle No 532

Maximum Design Freedom is Yours with **PANDUIT® *HI-CON*™ DIN Connectors**

Your high density packaging demands a variety of DIN connector types and styles to accommodate the requirements of the application. For SMT, VMEbus, Multibus II, backplane, high pin count or flat cable. Backed by more than 15 years of DIN connector experience, PANDUIT *HI-CON* connectors give you that freedom of choice.

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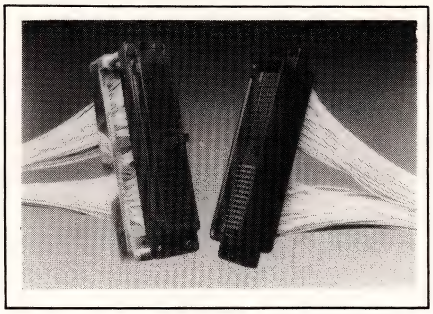
- Simple coding system allows over 1000 combinations for multiple backplane connections.
- Full line of accessories to adapt to special applications:
  —Cable housings for round or flat cable.
  —Adapters for frontplane or backplane interface.

Get the DIN connectors that best meet your specs— PANDUIT *HI-CON* DIN connectors. Call 1-800-323-2428 toll free today and ask for *HI-CON* Product Mgr.
(In Illinois—1-312-532-1800)

PANDUIT CORP
ELECTRONICS GROUP
Tinley Park, IL 60477-0981
In Canada: Panduit (Canada) Limited

CIRCLE NO 161

Hardware and Interconnect Devices

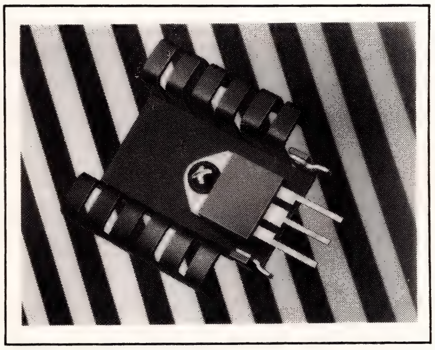


CONNECTOR

A rack-and-panel connector, the DL Drawer, features zero-insertion-force assembly to extend contact life and protect against mismating. It uses the axial thrust of a cam to move the contacts into high-force electrical contact. The connector's lifetime is 10,000 mate/unmate cycles minimum. The connector features layouts of 60 to 156 contacts configured on a 0.1-in. grid. Contacts come in strips and on reels for efficient crimping by crimp machines or stripper-crimper devices. Custom layouts with higher contact counts are also available. Prices range from $75 for a 60-contact mated connector to $150 for a 156-contact version. Delivery, 10 to 12 weeks ARO.

ITT Cannon, Box 8040, Fountain Valley, CA 92728. Phone (714) 964-7400.

Circle No 680



HEAT SINK

The 5931B heat sink utilizes stamp technology but provides the thermal performance of the more-expensive extruded devices, according to the company. Designed for TO-218 and TO-220 packages, it mounts in a vertical position and accommodates semiconductor devices on both sides. Under natural convection, the heat sink dissipates 10W max. The 1.64-in.-high heat sink has two solderable tabs for mounting. Made of aluminum alloy, the heat sink is available in gold chromate and black, red, blue, and bronze anodized finishes. $0.48 (1000).

Aavid Engineering Inc, Box 400, Laconia, NH 03247. Phone (603) 524-4443.

Circle No 681

PORT ADAPTER

This parallel-to-serial port converter, the Converser, converts the parallel port of an IBM PC or compatible system to a serial port, allowing you to drive a serial printer. Featuring an internal data buffer that stores the computer's output, the device connects directly to a parallel-printer cable and eliminates the need for serial-interface cards. Transparent to a computer and printer, the converter supports the most common serial protocols (X-On/X-Off, DTR), making it suitable for use with PCs and DEC printers. Two models are available: the PS-16, equipped with 16k bytes of buffer memory, and the PS-64, equipped with 64k bytes. PS-16, $149; PS-64, $229.

Gold Key Electronics Inc, Box 186, Goffstown, NH 03045. Phone (800) 325-0150; in NH, (603) 625-8218.

Circle No 683

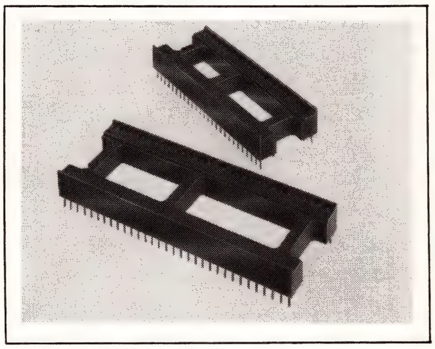
CONNECTOR COVER

The Snaplock connector cover has a copper/electrolysis nickel plating that meets or exceeds FCC requirements for EMI and RFI shielding. You assemble it entirely by hand with two ratchets and two cover halves, which saves production time and reduces cost. The connector cover is available in shielded and unshielded versions, and in 9-, 15-, 25-, and 37-pin positions. It accommodates any style of subminiature D connector: solder, crimp-snap, or insulation-displacement.

Because of its ratchet-design strain relief, the connector cover can accept a range of cable diameters without gates or grommets. Because the back part is also ratcheted, cable can protrude either from the back of the connector or at a 90° left or right angle. $0.95 (1000).

Interconnect Technologies Inc, 194-C Charlestown Rd, Malvern, PA 19355. Phone (215) 647-9260.

Circle No 682

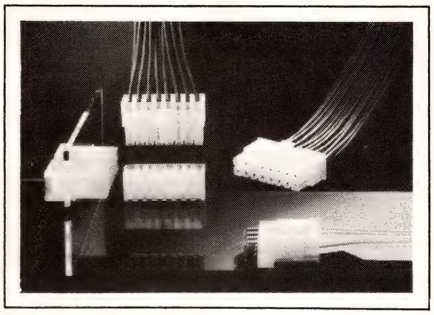


SOCKETS

Series 570 stamped pin sockets are designed for shrink-pack ICs that have a 0.07-in. pin-to-pin spacing. They feature single-beam contact pins that have a low insertion force. The glass-filled polyester housing has a 94V-0 UL rating and features guide rails to ease the insertion process. The contact pins are tin-plated beryllium copper. Units having 40 and 52 positions with pins on 0.6-in. centers are available, as are 64-position sockets with center spacings of 0.75 in. $1.67 (1000) for a 64-pin socket. Delivery, eight weeks ARO.

Aries Electronics Inc, Box 130, Frenchtown, NJ 08825. Phone (201) 996-6841.

Circle No 684



CONNECTOR

The Mini-Fit Jr is a pin-and-socket power connector that offers a current rating of 9A/circuit at 250V and a contact resistance of 10 mΩ/circuit max. It is available in wire-to-wire and wire-to-board versions: The mated length of the wire-to-wire version is 1.362 in.; the mated height of the wire-to-board version is 0.925 in. Terminals can be brass or phosphor bronze, plating can be tin or gold, and the housing can be UL 94V-0 nylon 6/6 or UL 94V-2 nylon 6/6. Current-rating specifications are 9A/circuit for a 2-circuit model; 8A/circuit for 4- and 6-circuit models; 7A/circuit for 8- and 10-circuit models; and 6A/circuit for 12-, 14-, and 16-circuit models. Insulation resistance is 1000 MΩ min; dielectric strength is 1500V ac.

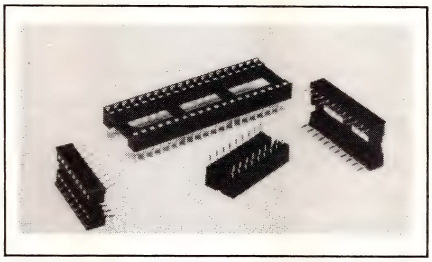
For pc-board applications, the connector comes as either a vertical- or right-angle header preassembled with terminals. It specs a temperature rise of 30°C max (carrying rated-current load); a mating force of 0.7 kg/circuit max; and an unmating force of 0.05 kg/circuit min. A standard connector with tin-plated brass terminals for 18- to 24-AWG wire costs $0.05.

Molex Inc, 2222 Wellington Ct, Lisle, IL 60532. Phone (312) 969-4550.

Circle No 685

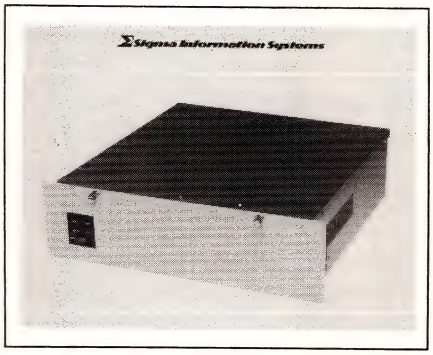
DIP SOCKETS

Series 812 dual-beam DIP sockets are available in 8- to 48-position versions. They feature crimped tails that hold the sockets in place during the soldering process. The dual-face-wipe contact design provides two points of contact with the IC lead. A 43° target angle allows easy, damage-free entry of device leads. The bottom of the socket is closed to eliminate solder wicking. A variety of contact materials and platings are available to meet specific application needs. A 16-position socket with phosphor-bronze, tin-plated contacts costs $0.126 (1000). Delivery, eight weeks ARO.



Wells Electronics Inc, 1701 S Main, South Bend, IN 46613. Phone (219) 287-5941.

Circle No 686



DISK ENCLOSURE

The SA-H163 is a rack-mount expansion enclosure for dual 5¼-in. Winchester disk drives, and is designed for applications that require removing, transporting, and storing disk drives. A removable drive bracket that you install on each 5¼-in. drive plugs into the expansion enclosure; the bracket includes drive-power and data connectors that permit you to plug in or remove drives without any need for tools or cabling. You can easily transport Winchester disk drives between systems.

The enclosure includes a 100W power supply, an exhaust fan, a front panel with write-protect switches and LEDs for each drive, and a controller-interface panel located at the rear of the chassis. Additional control and front-panel connectors provide daisy chaining for controllers that support as many as four 5¼-in. Winchester disk drives. $1431.

Sigma Sales, 3401 E La Palma Ave, Anaheim, CA 92806. Phone (714) 630-6553. TLX 298607.

Circle No 687

CONNECTOR SHELLS

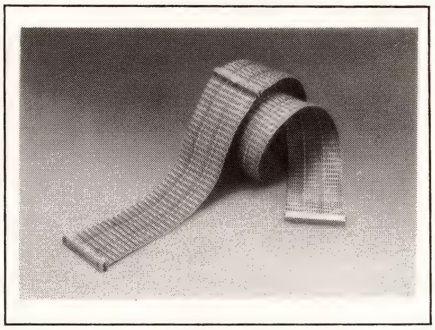
Complying with IEEE-802.3 requirements and US and European RFI/EMI shielding standards, these plastic connector shells for Ethernet drop cables offer RFI/EMI shielding protection equivalent to die-cast covers. They accept 15-way subminiature D connectors and feature a side-lock construction with a cable ferrule that allows easy cable termination. They are available in a range of colors; you can also have your company logo molded into the plastic shell (in most cases at no extra cost). Approximately $1.65.

Ossi Connectors Ltd, Unit C2, Priors Court, Priors Haw Rd, Corby, Northants NN17 1YG, UK. Phone (0536) 200963. TLX 265871.

Circle No 688

FLAT CABLE

You can specify Space-Mizer flat cable as a controlled-impedance, miniature-coaxial, or parallel-line

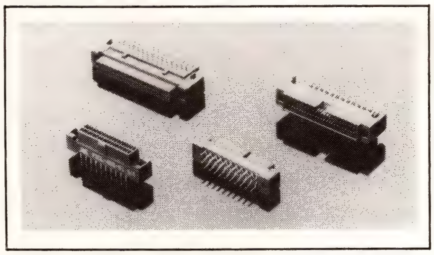


type. It comes in various shields and jackets. The cable can consist of different styles of wire; for example, a hybrid lead of coaxial; controlled-impedance 3-lead; and twisted-pair wire can satisfy mixed requirements within a common assembly. Closely controlled impedance and propagation delay allows the transmission of data signals with minimum loss or distortion. Conductors are on 50-mil center spacing, which allows termination at any point. The cable can terminate in special test sockets, such as pin-grid arrays and IC plugs, and it can come with branched harnesses for multiple-connector interfaces.

It's available on standard reels in increments of 100 feet, to a maximum of 300 feet. You may specify cable with 16, 20, 26, 34, 40, 50, 60, or 64 conductors. A 100-ft length of 26-conductor cable costs $74.36; 40-conductor, $103; 50-conductor, $125; 60-conductor, $144 (1000-ft qty).

Woven Electronics, Box 189, Mauldin, SC 29662. Phone (803) 963-5131. TWX 810-287-2091.

Circle No 691



CONNECTORS

PICL Series 2-piece connectors are designed for board-to-board applications. They feature a mating-side contact pitch of 0.05 in.; contact tails have a 0.1-in. contact spacing with

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Multifan . . . another example of the PAPST concept of Mechatronics. Electronic commands innovatively converted into direct and efficient mechanical movement. Call or write for a full line catalog.

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PAPST MECHATRONIC CORPORATION, Aquidneck Industrial Park,
Newport, RI 02840 (401) 849-8810 Telex 952092 1-800-551-6245
(Continental USA except for MA) 1-800-262-5226 (MA only)
Ask for Operator 31
INNOVATIVE DRIVE SYSTEMS AND FANS

CIRCLE NO 21

four staggered rows 0.075 in. apart. Combinations of straight and right-angle male and female connectors allow vertical, horizontal, and parallel board connections. Devices are available in 30-, 40-, 50-, and 60-contact layouts. Specs include a 0.5A current rating, a 1000V-ac dielectric withstanding voltage, a $10^8\Omega$ min insulation resistance, a 25-mΩ max contact resistance, and a −40 to +80°C operating range. From $4 (1000) for a mated pair. Delivery, stock to eight weeks ARO.

JAE Electronics Inc, 1901A E Carnegie Ave, Santa Ana, CA 92705. Phone (800) 523-7278; in CA and AK, (714) 250-7278. TLX 681438.

Circle No 689

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CARD CONNECTORS

Series 8113B polarized plug and socket connectors are rated to VDE 0110 grade B and meet UL 94V-0 flammability requirements. They mount flush with the pc board, preventing stress on the pin solder joints. Each plug connector is molded with a locking tab that protects it from vibration and shock. The units feature 5-mm pin spacings, and they're available in either horizontal or vertical configurations in 2- to 24-position versions. The connectors are rated for 300V at 10A or 250V at 15A, and they can accommodate wire sizes as great as 12 AWG.

The contact springs and solder pins are tin-plated bronze. The pressure clamps and screw assemblies are nickel-plated brass. The captive terminal screws prevent self-loosening by securing themselves when tightened. The connectors feature a braking action, which protects the wire from any pressure caused by overtightening. $4.32 (100) for a 12-position version.

Electrovert Inc, 466 Main St, New Rochelle, NY 10801. Phone (914) 633-0222.

Circle No 692

PGA SOCKETS

These decoupled pin-grid-array (PGA) sockets feature integral, surface-mounted, decoupling capacitors committed to the appropriate voltage and ground locations. Each socket includes two capacitors: a 1-μF capacitor for low frequencies and a 0.1-μF capacitor for high frquencies.

The sockets also employ a special ground plane as an interconnection vehicle between the ground termination of the capacitor and that of the socket, thus reducing inductance and providing a shield against noise. All connections, including those to V_{CC}, are accomplished via direct soldering. The socket pins are all screw-machined terminals that incorporate a low-insertion-

Do you still believe that a switch rugged enough to handle 100 amps inrush has to be big, ugly, and expensive?

Introducing Curvette SC™

Single or double pole. Lighted, unlighted, or VisiRocker™. We've taken our popular Curvette® rocker switch and beefed it up for high inrush applications.

Inside, Curvette SC is built to perform. Silver cadmium oxide contacts make it the toughest heavy-duty rocker in its class. The switching mechanism* minimizes arcing, greatly reduces contact bounce and the probability of contact weld. Inherent contact design dramatically increases contact pressure and improves heat dissipation. **Outside,** the glare-free matte finish and smooth compound-curve bezel complement any panel design.

Curvette SC delivers maximum performance and style for a price that's surprisingly affordable. **For a free sample,** write on your letterhead, or call Carlingswitch, Inc., 60 Johnson Ave., Plainville, CT 06062-1165. (203) 793-9281 TELEX: 710-425-0034 Toll Free: 1-800-243-8160

Single and double pole models. Lighted (AC and DC) and unlighted versions. VisiRocker™ model has low cost molded-in "on" indication. Custom legends available. Rated for 15AMP 250 VAC, 20AMP 125VAC, ¾ hp 125–250 VAC, 16(6)A 250VAC, and 6(6)A 250VAC (approvals pending).

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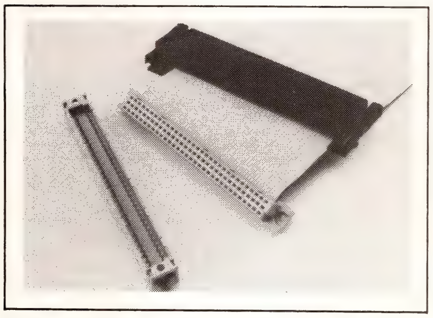
CARLINGSWITCH
INNOVATION BY DESIGN
CIRCLE NO 134

*patent pending

force, 4-finger beryllium-copper contact. The sockets decouple and mate with specific gate-array devices; for complete gate-array part-number references, contact the factory. $8.99. Delivery, four to eight weeks ARO.

Electronic Molding Co, 96 Mill St, Woonsocket, RI 02895. Phone (401) 769-3800. TWX 710-387-1350.

Circle No 693



CONNECTOR SYSTEM

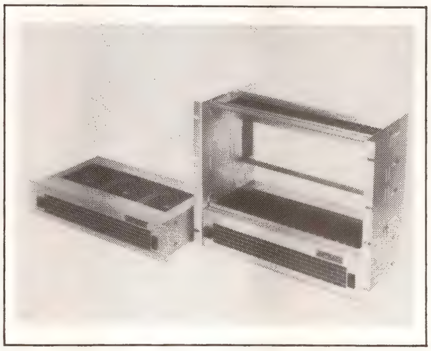
The 64-position Scotchflex insulation-displacement connector (IDC) system includes a plug, a socket, a pinless header, related accessories, and assembly tools. The system meets DIN 41612 blade-connector specs with controlled insertion-withdrawal force and 100% polarization. The DIN-compatible socket and plug allow daisy chaining, and the cover design allows closer stacking to maximize use of board space. The pinless header mates with the wrap posts of a 96-pin DIN connector. Assembly tools consist of hand-press locator plates for both the plug and the socket. Plug and socket, $6.34 (1000).

3M, Box 2963, Austin, TX 78769. Phone (512) 834-6563.

Circle No 694

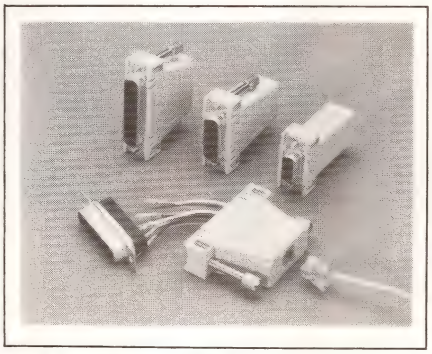
FAN ENCLOSURES

A Series RA Fan-Pak enclosure can hold as many as three 100-cfm fans, which draw cooling air through the front grill (face plate); the air is then pushed upwards at a right angle to cool the pc cards vertically mounted in a card cage directly above. Alternatively, you can buy one of these enclosures as an integral part of one of the manufacturer's pc-card cages. Enclosures are available to fit all sizes of pc boards, and all are wired and have a 6-ft line cord, a front-mounted power-on/off switch, and a fuse holder. $125 for an enclosure holding three fans; $154 with cage (Part #RA-KK 119-975) (card guides not included).



Unitrak/Calabro Industries Inc, Goshen Corporate Park, Box 1927, West Chester, PA 19380. Phone (215) 692-0800.

Circle No 695

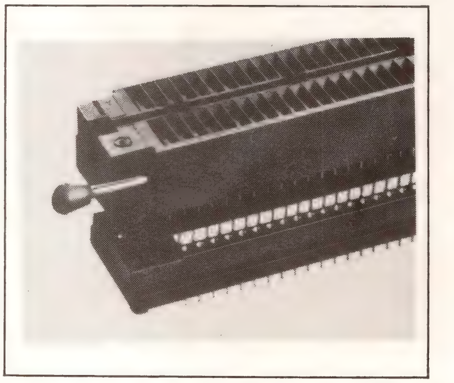


ADAPTER KITS

These Modular Adapter Kits consist of programmable wiring mates for DB9, DB15, and DB25 connectors. They eliminate the need to connect and disconnect bulky, expensive data cables whenever you need to move a peripheral. Each adapter connects to an appropriate D subminiature connector and accepts the traditional modular telephone cable at the other end. You can choose from eight kits: male or female DB9 to RJ45, male or female DB15 to RJ45, male or female DB25 to RJ45; and male or female DB25 to RJ11. $6.95 to $8.95.

L-COM Data Products, 1755 Osgood St, North Andover, MA 01845. Phone (617) 682-6936. FAX 617-689-9484.

Circle No 696



ZIF SOCKETS

This company's line of 24-, 28-, and 40-pin ZIF test sockets now includes 32- and 48-pin versions. They are designed with a very broad contact area to accommodate ICs with 0.300, 0.400, or 0.600 centers and leads from 0.015 to 0.045 wide. Contacts are gold- or tin-plated beryllium copper; other platings and base metals are available for burn-in applications above 150°C.

The contacts are normally closed to provide consistent force and to prevent contact deformation from oversized loads. Each test socket can either mount directly on a pc board or it can bolt to its receptacle, which would then bolt to the pc board. Alternatively, you can bolt the test socket and receptacle together (bolts are furnished). The housing of both the socket and the receptacle are UL 94V-O rated. 32-pin tin-plated socket, $4.97; 32-pin gold-collet, tin-shell receptacle, $3.90 (100).

Aries Electronics Inc, Box 130, Frenchtown, NJ 08825. Phone (201) 996-6841.

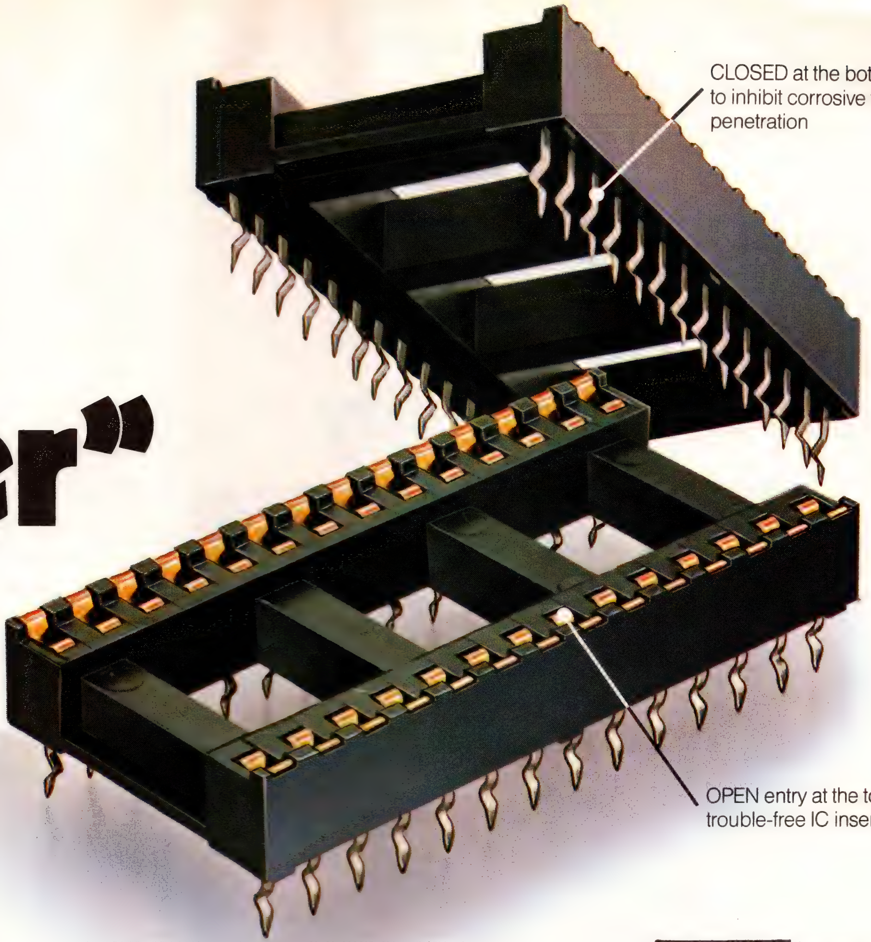
Circle No 697

F-O INTERFACE

The Data Channel is a fiber-optic-to-RS-232C interface for office and industrial data communication. The

New RN economy production socket...

"flux fighter"

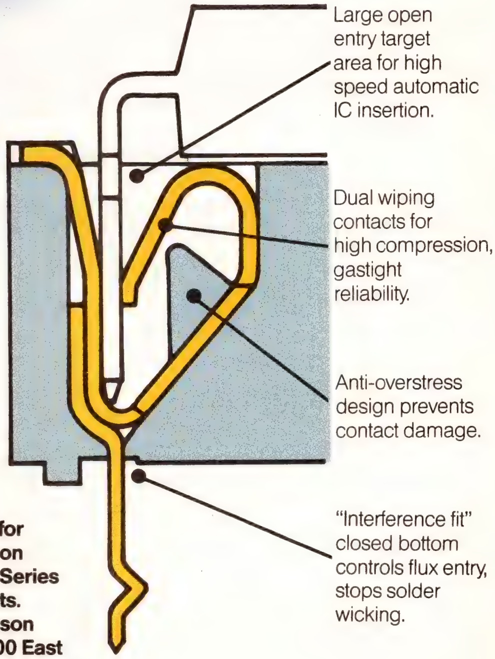

CLOSED at the bottom to inhibit corrosive flux penetration
OPEN entry at the top for trouble-free IC insertion

At this price – 60% less than machined sockets – you can't buy a socket that controls flux and solder more effectively.

This new Robinson Nugent socket is the first really low cost production socket that keeps flux entry to a minimum—and does it at a cost of much less than a penny per pin! Solder wicking is completely prevented. This new RN socket is closed at the bottom to inhibit corrosive flux entry. And it is open at the top for fast trouble-free automatic or manual IC insertion. Other unique advantages include:

- Dual side-wipe contacts for gastight reliability
- Anti-overstress design that prevents abuse to the contact
- Choice of 6 to 64 contacts
- Available in economical copper alloy or heavy duty beryllium copper contacts

Cut away of the ICO/ICB socket reveals high reliability design features


Large open entry target area for high speed automatic IC insertion.
Dual wiping contacts for high compression, gastight reliability.
Anti-overstress design prevents contact damage.
"Interference fit" closed bottom controls flux entry, stops solder wicking.

WRITE TODAY for complete data on these low cost Series ICO/ICB sockets. Contact: Robinson Nugent, Inc., 800 East Eighth St., New Albany, IN 47150. Phone: (812) 945-0211.

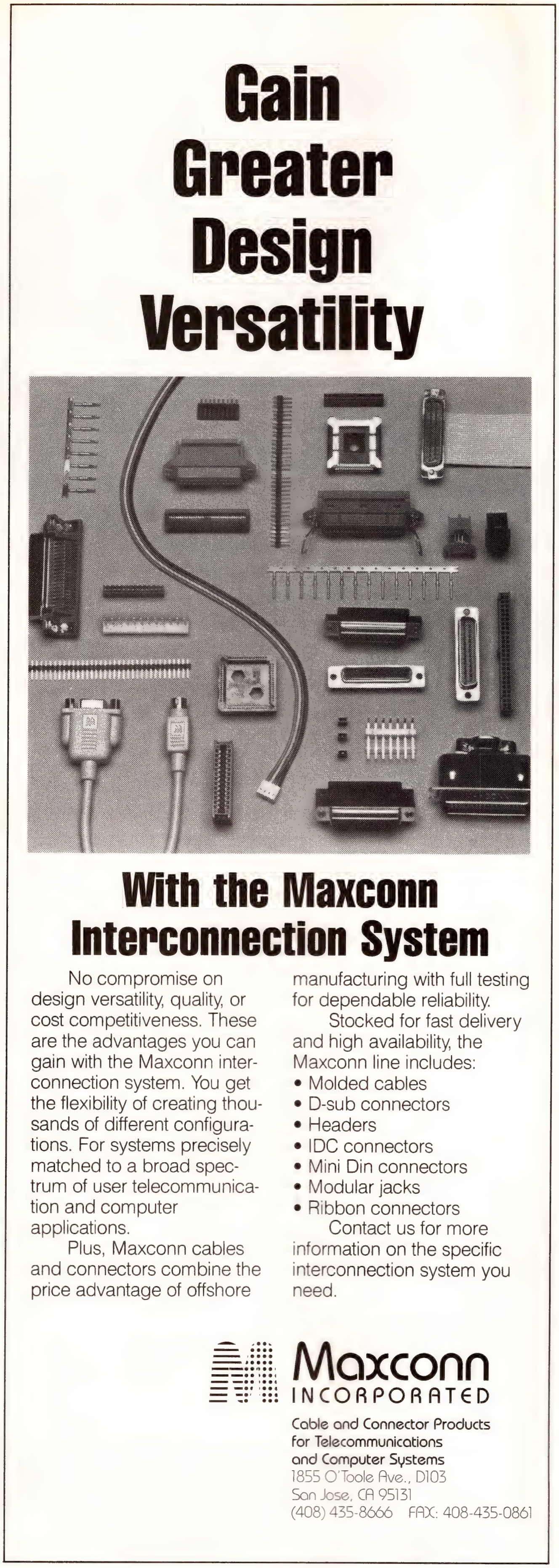
. . . connect with quality

RN

Robinson Nugent

800 East Eighth Street, New Albany, Indiana 47150 ▪ Phone: (812) 945-0211
In Europe: Rue St. Georges 6, CH 2800 Delémont, Switzerland ▪ Phone: (066) 22 98 22

CIRCLE NO 165



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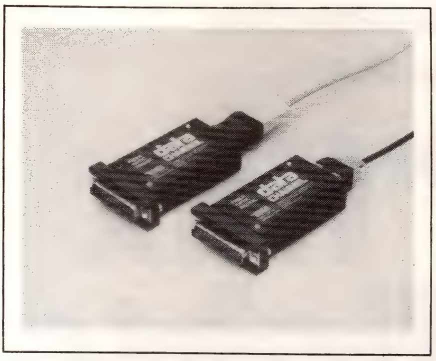
CIRCLE NO 23

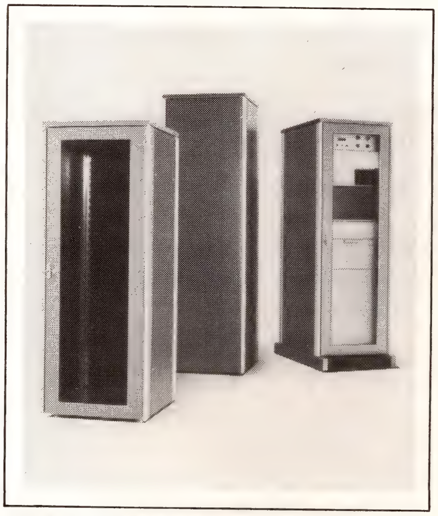


system establishes an electrically noise-free data link between RS-232C-compatible devices without the need for special fiber-optic light sources or power supplies. It uses nonconductive fiber-optic cable and seals all electronics in a metal case for protection against EMI.

The duplex asynchronous transceiver's design can handle 0k- to 20k-bps NRZ data at distances to 130m (with plastic fiber) or to 4 km (with glass fiber). A typical fiber-optic link consists of two Data Channel modules (in 25-pin D-connector configurations for either DTE-type or DCE-type RS-232C equipment), fiber-optic cable, and connectors. A power supply is optional. $115 (10 to 50).

Thomas & Betts Corp, 920 Rte 202, Raritan, NJ 08869. Phone (201) 685-1600. TLX 833190.

Circle No 698



19-IN. CABINET

The Model 48 lightweight, easy-to-assemble cabinet comes in five heights (21, 26.25, 31.5, 42, and 56 in.) and three depths (15.74, 23.62, and 31.50 in.). Mounting dimensions conform to DIN 41494, Part 1. Aluminum die-cast parts and sections make up the self-supporting frame, onto which you can mount various accessories. Panels and doors are steel; side panels are available with or without ventilation slots. Front doors can be solid or brown plexiglass.

The vendor ships the unit in kit form. Accessories include leveling feet, castors, lifting eyes, grounding sets, L brackets, dust-proof seals, support rails, guide rails for subracks, front panels, a drawer, a fan tray, and a pull-out tray. A basic cabinet measuring 21×19×15.74 in. sells for $350.

ELMA Electronic Inc, 41440 Christy St, Fremont, CA 94538. Phone (415) 656-3400. FAX 415-656-3783.

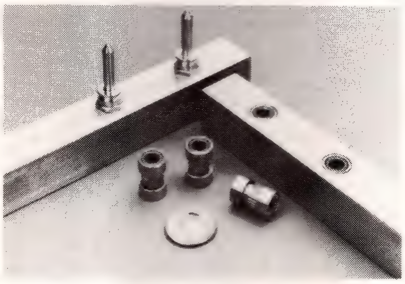
Circle No 700

PLASTIC ACCESSORIES

This manufacturer's plastic accessories are now color coded for quick identification. The Nylon PC Card Guide, the Anti-Vibration Nylon PC Card Guide, the PC "Butterfly-Design" Card Guide, the PC Card Injector/Ejector, the PC Card Ejector, and the PC Board Retaining Bar are available in red, green, blue, yellow, purple, orange, black, and white. Prices start at $0.12.

Electro-Space Fabricators Inc, 300 W High St, Topton, PA 19562. Phone (215) 682-7181.

Circle No 699



200A SOCKET

A 200A low-insertion-force socket, the HPG241F32, can be press fit into machined recesses in electrical bus bars. The socket and its mating pin provides an alternative to labor-intensive, space-consuming flat and terminal/cable assemblies. The plug-in bus system allows factory-assembled testing, easy sectioning for shipment, and fast field setup and checking. The socket incorporates a Hypertacr contact that provides low insertion force and virtual immunity to shock and vibration. $10.73 (100). Delivery, six to eight weeks ARO.

Hypertronics Corp, 16 Brent Dr, Hudson, MA 01749. Phone (800) 225-9228; in MA, (617) 568-0451. TLX 951152.

Circle No 701

ENCLOSURE

The Flat-Top enclosure is engineered especially for the control-room environment. It features a sturdy 14-gauge steel frame reinforced with four 11-gauge corner gussets and seam-welded components. You have a choice of three panel widths, four frame depths, and three slope openings. You also have a choice of two versions: the C, or computer, version, with decora-

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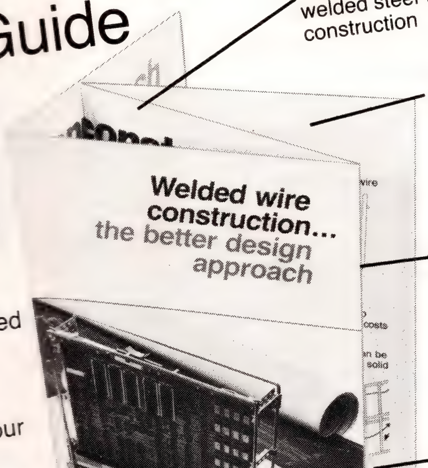
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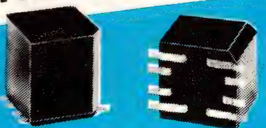

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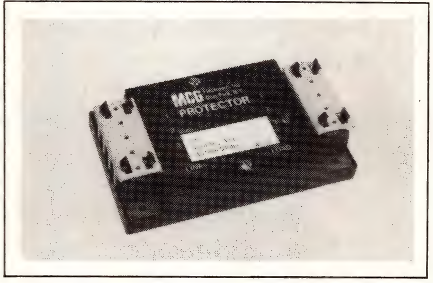
CIRCLE NO 25

tive trim; and the S, or industrial, version, with square corners and no trim. Various accessories and different sizes are also available. $400 to $600, depending on size. Delivery, stock to five weeks ARO.

Cabtron Systems Inc, 200 Anets Dr, Northbrook, IL 60062. Phone (312) 498-6090.

Circle No 702

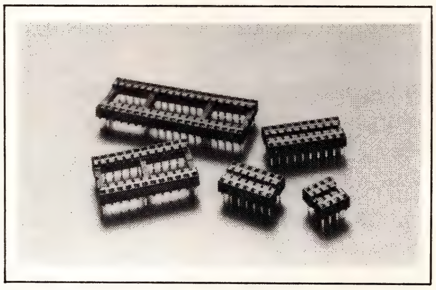


SURGE PROTECTOR

Model 415 protects 120V ac, single-phase, 50/60/400-Hz power lines (with current-handling capabilities of 15A) against high-speed lightning, transients, and surges. The protector clamps IEEE-587-defined ring and impulse waves to safe levels and automatically resets to wait for the next transient. It incorporates high-speed (less than 1-nsec) brute-force protection components and impulse filtering to prevent damage or malfunction, and its transient-absorption capability exceeds 480J. EMI/RFI filtering provides good attenuation at lower frequencies: 20 dB at 65 kHz, 40 dB at 170 kHz, and 60 dB at 650 kHz. You can easily install the protector within a piece of equipment. A green LED indicates that the unit is operational and protected. Military versions are available. $49.

MCG Electronics Inc, 12 Burt Dr, Deer Park, NY 11729. Phone (516) 586-5125. FAX 516-586-5120.

Circle No 703



DIP SOCKETS

The FSWP/FSWB Series consists of single-beam DIP sockets available with 8, 14, 16, 18, 20, 24, 28, or 40 contacts. These antiwicking sockets come with either phospher-bronze or beryllium-copper contacts sealed in a UL 94V-0 glass-filled polyester body. Standoffs facilitate cleaning, provide ventilation, and ensure proper wave soldering.

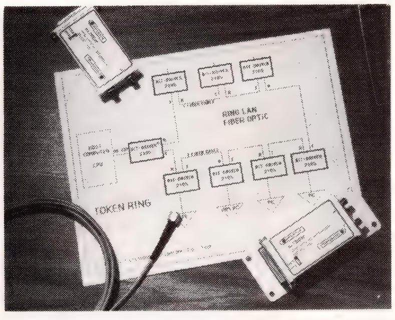
A restricted funnel-shaped entry guides IC leads. The sockets are packaged in standard tubes with color-coded stoppers that designate the number of contacts. A typical phosphor-bronze 16-contact socket costs $0.15 (1000).

Precicontact Inc, Box 798, Langhorne, PA 19047. Phone (215) 757-1202. TLX 834253.

Circle No 704

F-O INTERFACES

The 2105/2106 Bit-Driver mini-modems are fiber-optic transmitter/receiver units for use with 56k-bps token-ring networks. Designed for long-distance or EMI/RFI-susceptible network installations, the 2105 is an RS-232C-to-fiber-optic module that uses a single fiber link to send data at 56k bps; the 2106 is similar

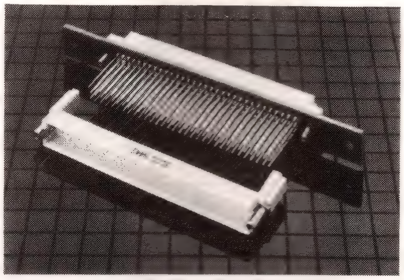


but uses an RS-422 interface. The modules can plug directly into a computer's serial port, eliminating any need for RS-232C or RS-422 cable assemblies.

The units interface to the fiber-optic cable via standard SMA connectors. They are capable of simplex or full-duplex operation and have 6000-ft max distance capability. Line-status indicators are standard. $200.

SI Tech Inc, Box 609, Geneva, IL 60134. Phone (312) 232-8640.

Circle No 705

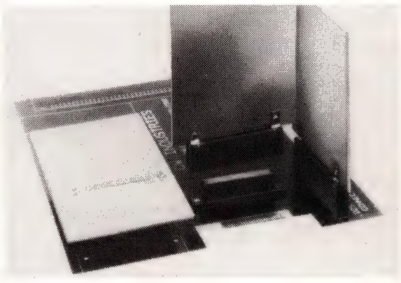


I/O CONNECTOR

The Series 8442 3-row, 96-contact connector, when mated with a Series 8458 or 8478 press-fit connector on a pc board, forms a gas-tight connection between the pins, the through-hole plating, and the internal printed circuits. The I/O-pin insulator housing prevents the shimming problems associated with wire-wrapping and shrouding press-fit connectors. The connector also helps minimize stress on the board and plated through holes. $2 (including locking hardware).

Elco Corp, Huntingdon Industrial Park, Huntingdon, PA 16652. Phone (814) 643-0700.

Circle No 707



CONNECTOR

The CMB Series socket/post connector is an addition to the company's Nano IDC connector system. It permits the direct connection of pc boards without cables, and it allows you to directly connect pc boards in parallel and perpendicular configurations with full connect/disconnect capability. It also eliminates the need for pc-board or IDC card-edge

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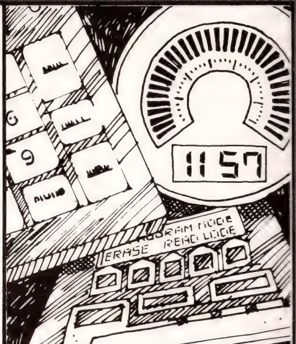

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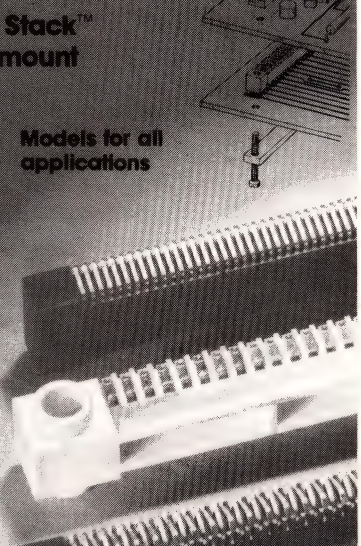


connectors.

The posts mount on 0.050×0.100-in. centers. The socket end of the connector mates with a Nano header having 0.050×0.050-in. centers. This connector is available with either 50 or 26 contacts. The contact length can be 0.09 in. for mating with ¹⁄₁₆-in.-thick pc boards or 0.060 in. for connecting to ¹⁄₃₂-in.-thick boards. The connector's body is made of flame-retardant thermoplastic. The standard plating is selectively plated 30-μin. gold over 50-μin. nickel on the socket end and 100-μin. lead-tin on the solder post end. $7 per connector; $11.25 per mated pair (1000).

CW Industries, 130 James Way, Southampton, PA 18966. Phone (215) 355-7080.

Circle No 708

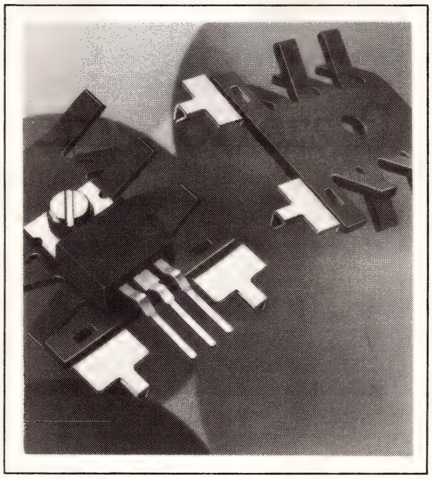
RACK ENCLOSURES

RME Series 19-in. rack-mount enclosures are intended for IBM PC/XTs, PC/ATs, and compatibles where the available desktop area is inadequate. Model RME-900 features an internal CGA-resolution, 8¾-in.-high RGB monitor. Model RME-901 has either an EGA- or CGA-resolution monitor. Each enclosure accommodates front-panel mounting of one or two half-height hard-disk drives. Model KBD-100 uses an external or a Model RMC-140 monitor, and provides mounting for two full-height and two half-height drives. You can replace one of the full-height drives with two half-height drives. Model RMC-140 has a 14-in. color monitor compatible with CGA or EGA displays.

A front-panel fan and replaceable filter provides filtered, forced-air cooling. A full-size PC/AT or smaller PC/XT board will mount in any RME enclosure—you only need a screwdriver. You can plug in as many as eight PC/AT boards. The enclosures don't include a computer board, drives, or a power supply. RME-900, $995; RME-901, $1145; KBD-100, $175; RMC-140, $745.

Recortec Inc, 275 Santa Ana Ct, Sunnyvale, CA 94086. Phone (408) 737-8441. TWX 910-379-5022.

Circle No 706

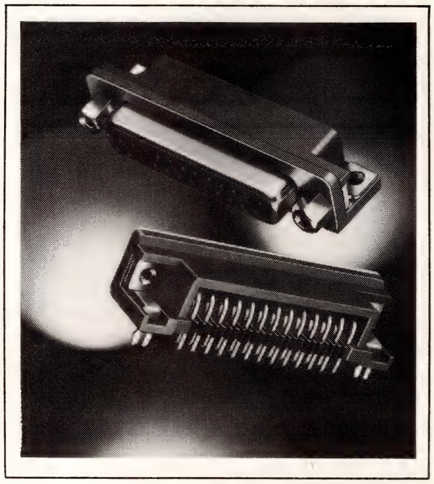


HEAT SINK

The 5225-XT is a heat sink with triangular, mechanically affixed "XT" tabs for more stable mounting on pc boards. Intended for use with TO-220 cans, this vertically mounted heat sink is anodized before having its tabs affixed, saving plating and painting operations. The TO-220 package is 0.30 in. away from the pc board for minimum heating of the semiconductor during soldering operations. The heat sink measures 1.275 in. above the board and has alternating fins that increase air turbulence. With an input of 3W and under natural convection, it has a thermal resistance of 18°C/W. The part is made of aluminum alloy and is available in gold chromate and either black, red, bronze, or blue anodized finishes. $0.17 (1000).

Aavid Engineering Inc, 1 Kool Path, Laconia, NH 03247. Phone (603) 528-3400. FAX 603-528-1478.

Circle No 709

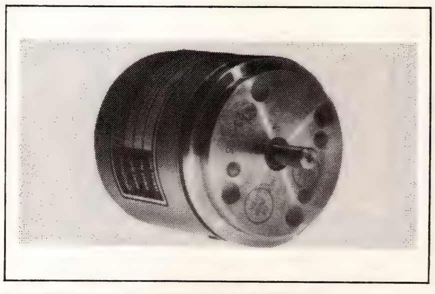


D CONNECTORS

Theta-D Series plastic connectors have metal shells, are designed specifically for pc-board applications, and are compatible with D subminiature connectors. These right-angle-mounted connectors are available in plug or socket versions and offer a choice of 9, 15, 25, or 37 gold-plated contacts. Setback configurations can be 0.590 in. or the European 0.318 in. Options include mounting holes, threaded-steel standoffs for RS-232C cable assemblies, and #4-40 threaded inserts for bulkhead mounting. Three grounding arrangements are possible: A forked ground that provides for easy wave soldering; an internal ground that features a ground strap along the top surface; and a combination ground that has a strap that wraps around the mounting end and underneath. $1.53 (500).

Vernitron Corp, Beau Products Div, Dept P7-1, Box 10, Laconia, NH 03247. Phone (603) 524-5101. FAX 603-524-1627.

Circle No 710



OPTICAL ENCODER

The LSI Microseries Model 13/23K optical encoder is a shaft-angle type that provides a resolution of 2.64 arc-minutes and an accuracy of 1.3 arc-minutes. It comes in a 2.09×2.30-in. environmentally

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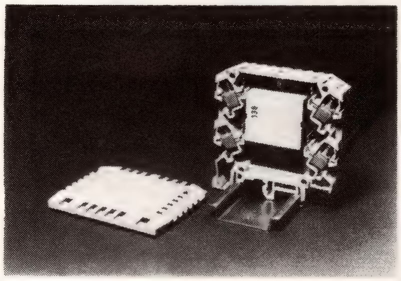
sealed case and is similar to the company's high-resolution LSI MS/23 Series, but costs less and provides less resolution. The encoder provides 12- or 13-bit resolution with either a parallel or serial output. When an encoder is in the serial-output mode, the user can provide an interrogate signal, which provides the hold function and loads a shift register. This hold signal prevents any bit from changing state while you're taking a reading. Shift-clock pulses serially shift out the stored data. $16.50 (50 to 100). Delivery, 60 days ARO.

Litton/Itek Encoder, 27 Christina St, Newton, MA 02164. Phone (617) 969-7300. TWX 710-335-6783.

Circle No 711



RELAY BLOCKS

Series 10,000 rail-mounted relay terminals simplify component packaging and circuit interfacing. The line contains 11 models rated from 24V ac/dc to 220V ac; block thickness is 18 or 23 mm, depending on the unit. The blocks mount on standard DIN rails, eliminating the need for a separate relay socket, and low-current relay-coil circuitry is separate from the high-current-carrying contacts, reducing EMI. All the blocks with screw terminals accept #12-AWG wire. All blocks feature an LED indicator, which turns on when the relay is energized. The operating-temperature range is 32 to 104°F. Model RB 121 A, #10004.21, a 24V ac/dc block containing one spdt contact, costs $15.38 (100).

Entrelec, 2 Ram Ridge Rd, Spring Valley, NY 10977. Phone (800) 431-2308; in NY, (914) 425-7460. FAX 914-425-8108.

Circle No 712

HEAT EXCHANGER

The HX-38DF heat exchanger has a double-fan configuration, which boosts air flow to overcome the impedance caused by a dense arrangement of components in the enclosure. Its closed-loop design maintains the integrity of an NEMA seal, allowing only clean air to cool the electronics and sealing out hostile ambient air. The heat exchanger uses standard 6-in. axial fans, which you can easily replace from local sources, when necessary. You can mount it on any surface or door, outside or inside an enclosure. Its dimensions are 38¼×2 1/16×20 in.

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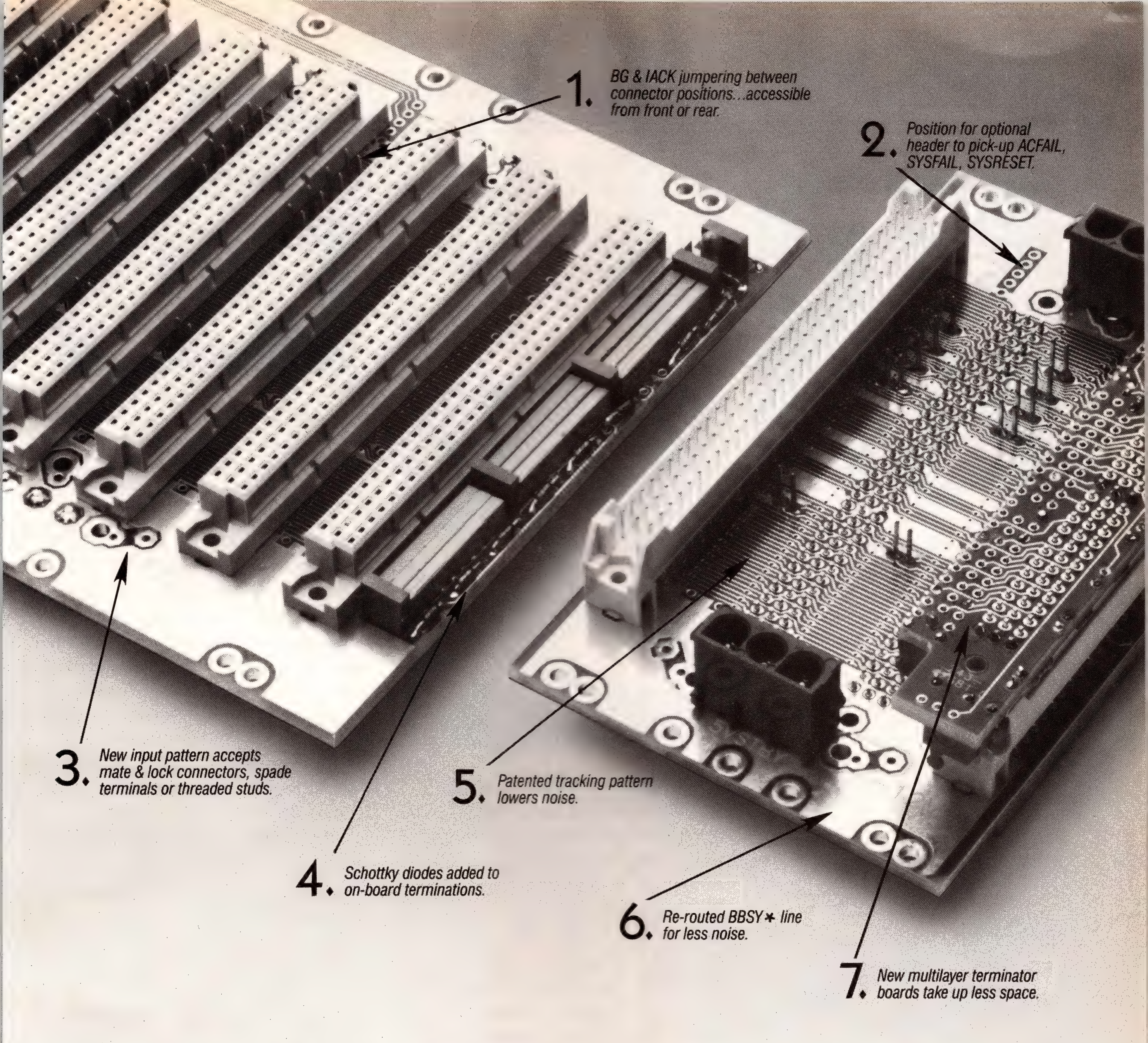

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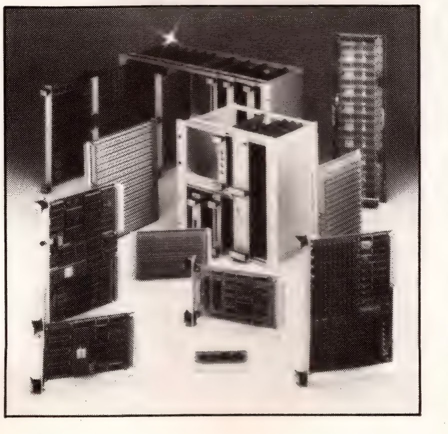

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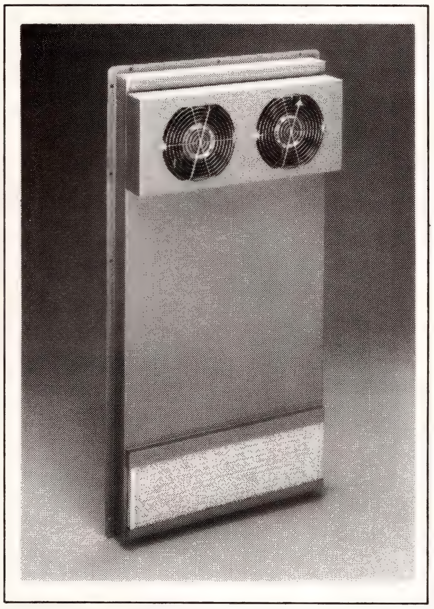
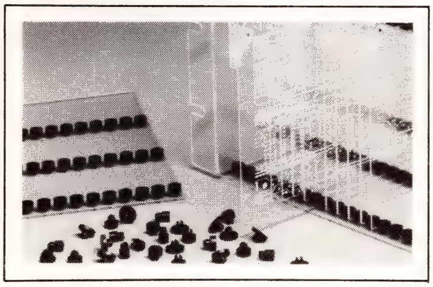


(the width dimension doesn't take into account the fan housings). $473 (25).

Mclean Midwest, 4000 83rd Ave N, Brooklyn Park, MN 55443. Phone (612) 561-9400. TLX 290883.

Circle No 715



CARD GUIDES

The Circ-O-Gide is a circular-shaped snap-in card guide that snaps into 0.172-in.-diameter holes in any mounting base with a thickness of 0.047 to 0.090 in. The circular-vs-full-length design allows for maximum air flow without any loss of packaging or board-spacing density. Installation requires no special tools: You can do it by hand. Positioned to allow a 0.076-in. gap for 1⁄16-in.-thick pc boards, the card guide is available for 0.312-, 0.400-, 0.500-, 0.600-, 0.750-, 0.800-, and 1.000-in. standard spacings. Each version is available in five thicknesses from 0.078 to 0.187 in. It is made of black, glass-reinforced nylon per ASTM D4066 and is UL rated 94V-0. Typical pricing is $38.50/1000 in lots of 10,000.

Bivar Inc, 4 Thomas, Irvine, CA 92714. Phone (714) 951-8808. FAX 714-951-3974.

Circle No 716

STRAIN-RELIEF COVER

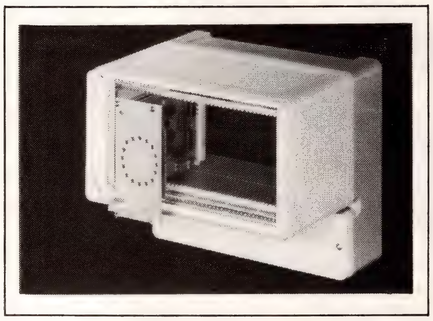
This strain-relief cover, for use with the Mas-Con connector system, provides additional strain relief in high-vibration applications by holding each wire into the slot. You can use this cover with both end and through connectors. It's available for 0.100- and 0.156-in. Mas-Con mass-terminated connector systems. The 0.100-in.-spacing connectors can have two to 28 circuits, and the 0.156-in.-spacing connectors can have two to 24 circuits. $0.06 to $.63 (OEM qty).

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800.

Circle No 717

ENCLOSURE

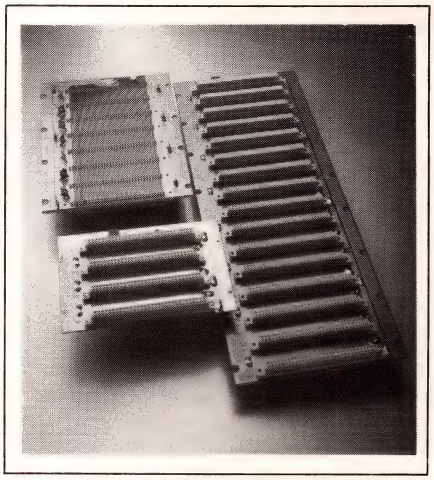
The Vario-box enclosure system allows you to build nine wall-mounting housings and 21 tabletop units from standard component parts. The enclosures are 264 mm wide and 150 mm high and have a sectional construction that allows you to achieve a depth of 90 to 256 mm; special rear sections allow the enclosures to be mounted on the wall. In addition, the enclosures are available with a terminal compartment that increases the overall height to 230 mm.



Other options include left- or right-hinged transparent front covers with provisions for screw or lock catches; card racks capable of accepting as many as seven Eurocards; and various front panels and 19-in. accessories. Tabletop versions are available with integrated tilting feet or with a handle that allows 30° rotation, enabling the enclosure to double as a tilt stand. Prices start at around $20.

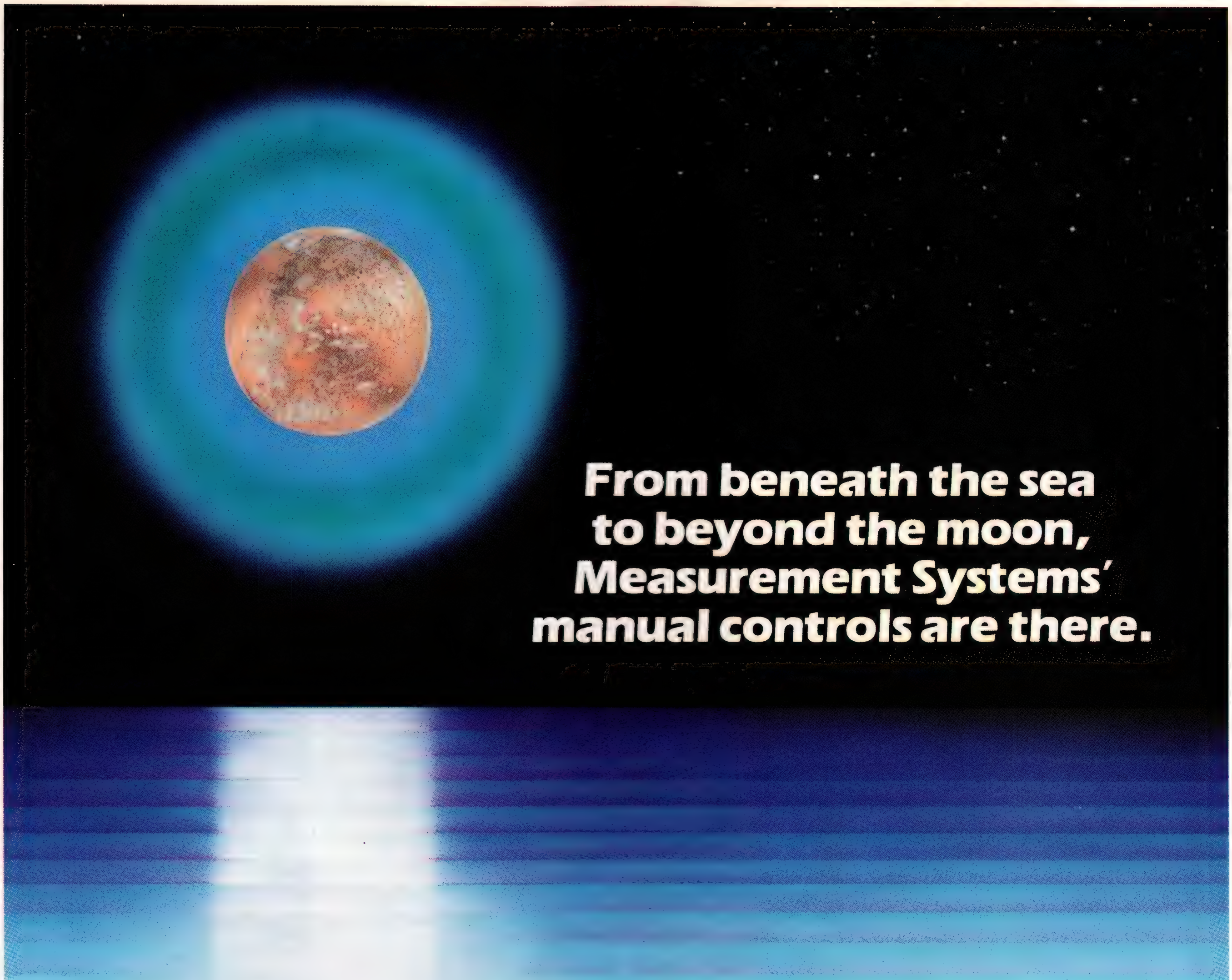
Odenwälder Kunsttstoffwerke GmbH, Postfach 1341, D-6967 Buchen/Odenwald, West Germany. Phone (06281) 4040.

Circle No 718



BACKPLANES

These G64 Bus backplanes comply with the November 1984 revision of the G64 Bus specification and are available in 4-, 8-, 12-, 16-, and 20-slot versions. They come with a 5V regulator, 1⁄4-in. spade terminals for



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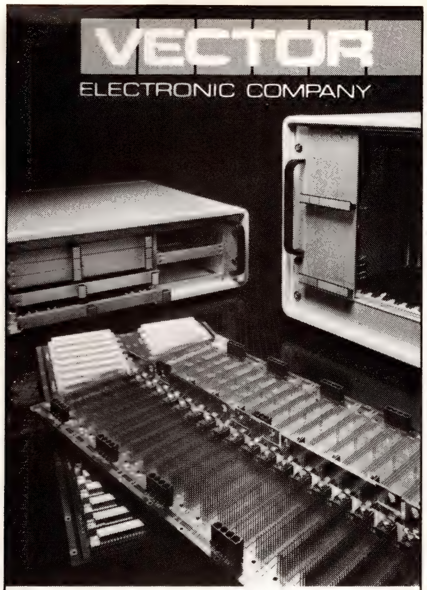

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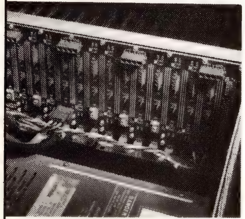

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power connections, and DIN-41612 connectors with a 0.8-in. slot spacing. The backplanes are unterminated and can support 1-MHz data-transfer rates. The double-sided, through-hole-plated boards are coated with solder-resist material, and they feature a ground plane on the component side to ensure that the signal tracks have a uniform characteristic impedance. Prices range from £39.46 for a 4-slot backplane to £125.56 for a 20-slot backplane.

BICC-Vero Electronics Ltd, Flanders Rd, Hedge End, Southampton SO3 3LG, UK. Phone (0703) 266300. TLX 477984.

Circle No 719

BICC-Vero Electronics Inc, 100 Sherman Ave, Hamden, CT 06514. Phone (203) 288-8001. TWX 510-227-8890.

Circle No 720

FLAT-CABLE MOUNTS

These flat-cable all-nylon mounts accommodate cable that's either $1\frac{13}{64}$ or $3\frac{1}{4}$ in. wide. Both mounts can accommodate a stack height of $\frac{11}{64}$ in. You can specify adhesive backing, or you can opt for #6 screws. Adhesive-backed mounts offer convenient, fast installation; screw-applied mounts provide increased support. The mounts' 1-piece design speeds installation and reduces cost, and they also snap-open easily for flat-cable revisions. $0.25 to $0.40 (OEM qty).

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800.

Circle No 713

EDGE CONNECTORS

These compliant-pin card-edge connectors reduce assembly time and costs by eliminating the need for soldering. The flexible twin-beam construction in the compliant section and the rounded surfaces provide a gas-tight joint. You can re-

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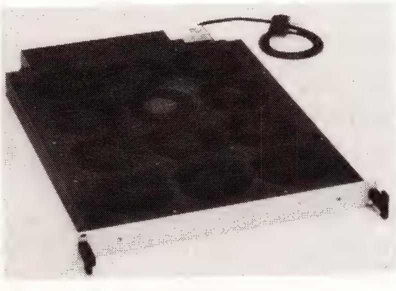
These connectors are interchangeable with devices that have a 0.1×0.2-in. grid spacing. They range in size from 15 to 65 positions and feature selective gold plating. The connectors are available in a number of configurations (including high and low profile) and a choice of card-slot depths, termination lengths, and open or closed ends. Contacts fit on 0.062-, 0.093-, and 0.125-in.-thick pc boards; the maximum insertion force equals 40 lbs, and the minimum retention force per contact is 10 lbs. $0.03 per contact (10,000).

Viking Connectors Co, Box 2379, Chatsworth, CA 91311. Phone (818) 341-4330.

Circle No 690



FAN TRAY

The Airmatic 3000 fan tray features automatic temperature-sensing and fan-speed control to maintain optimum operating temperatures in 19-in. rack systems. In addition, a built-in alarm system warns of overtemperature conditions. The fan tray consists of plastic-foam top and bottom moldings, which fit together to form an anechoic enclosure to reduce operating-noise levels. The fans fit into this enclosure and rest on rubber mounting pads; the top molding incorporates finger guards. You can mount six to 15 fans anywhere within the matrix of fan-mounting holes. Optionally, the tray is available without the automatic fan-speed control if you want to use line-powered ac fans. Prices for trays with speed control range from DM 613 to DM 1600; without speed control, from DM 281 to DM 1335.

Knurr AG, Schatzbogen 29, 8000 Munich 82, West Germany. Phone (089) 420040. TLX 52960810.

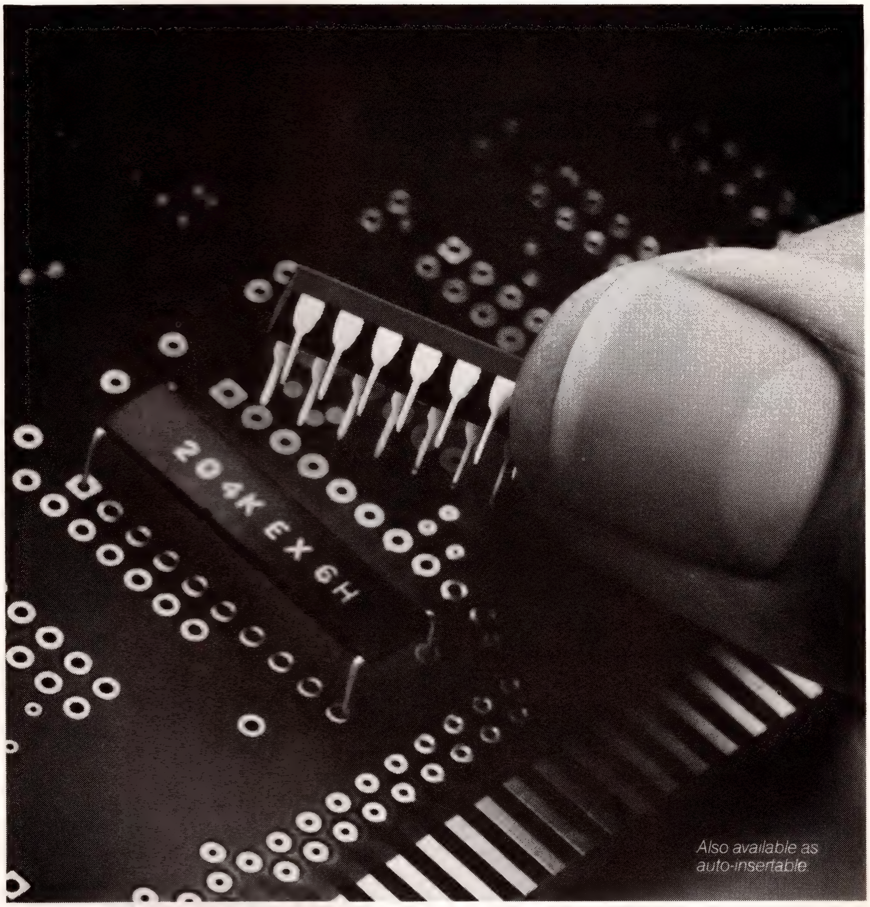
Circle No 721

Dacobas Inc, 1830A N Voyager Ave, Simi Valley, CA 93063. Phone (805) 526-7733. TWX 910-350-5103.

Circle No 722

CONNECTORS

This series of pc-board-mount BNC connectors includes models for horizontal- or vertical-mounting applications. Each socket body incorpo-



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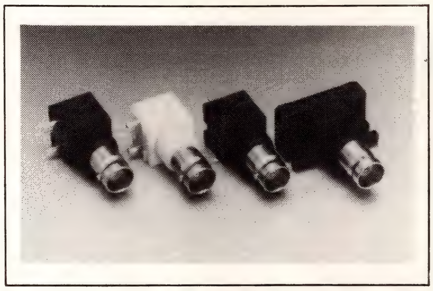
CIRCLE NO 30

rates a molded thread to secure the connector to panels 4 mm thick; a flat surface on one side of the thread resists the rotational torque associated with inserting and removing a mating plug. You can affix the connector to a pc board either with self-tapping screws or by soldering special mounting pins. The polypropylene body molding insulates the connector from the pc board and from the panel and provides an insulation resistance of >500 MΩ. In addition, it incorporates standoffs that allow solvent cleaners to penetrate beneath the connector assembly.



The connectors have a nominal impedance of 50Ω and a working voltage of 500V dc or ac pk. The silver-plated contacts meet the requirements of BS-9210 N0001 Part 2 and MIL-C-39102. The connectors have an operating-temperature range of −40 to +85°C. A special low-profile version is also available. Around $0.95 (OEM qty).

Greenpar Connectors, Cambridge Rd, Harlow, Essex CM20 2ER, UK. Phone (0279) 27192. TLX 81404.

Circle No 723

Automatic Connector Inc, 400 Moreland Rd, Commack, NY 11725. Phone (516) 543-5000. TWX 510-226-3744.

Circle No 724

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Sealed to withstand environmental conditions in excess of those specified by IP67, the MPL34 panel lamp is suited for use in military or portable equipment. It includes a high-intensity red/green LED, and it has a low-profile Fresnel lens assembly to maximize light output. You have a choice of two versions with different brightness levels and either a black or an anodized-aluminum bezel finish.

The panel lamp has a metal body and attaches to a panel with a sealing washer, lock washer, and nut. Its terminals accept soldered, wire-wrapped, or push-fit connections. The lamp meets the requirements of BS-5420 and has an operating- and storage-temperature range of −30 to +85°C. Approximately $3.80.

Marl International Ltd, Ulverston, Cumbria LA12 7RY, UK. Phone (0229) 52430. TLX 65100.

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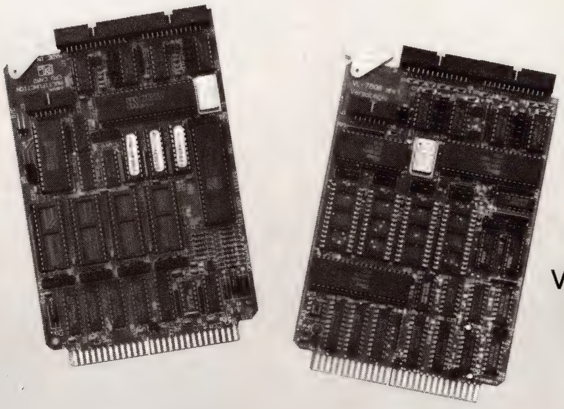

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RIFA

INTERFERENCE SUPPRESSORS
General Technical information

The tests described below are those among the tests which are significant for capacitors used as interference suppressors for which national approvals are required.

Standard	Test voltage in type test	Endurance test at +85 (100)°C 1000 h
SEN 432901 (IEC 161)		
X-application	1075 VDC 1 min	1.5 × U_R
Y-application	1500 VAC 1 min	1.7 × U_R
EMKO 1(N, D, El)		
X-application	1075 VDC 1 min	1.5 × U_R + 1000 V, 50 Hz 0.1 sec each hour*
Y-application	1500 VAC 1 min	1.7 × U_R + 1000 V, 50 Hz 0.1 sec each hour*
SEV		
X-application	1075 VDC 1 min 3 kV surge**	1.5 × U_R
Y-application	1500 VAC 1 min 5 kV surge**	1.7 × U_R
VDE 0565-1		
X-application	1075 VDC 1 min (X_1, X_2) 4 kV surge (X1)**	1.25 × U_R + 1000 V, 50 Hz 0.1 sec each hour*
Y-application	1500 VAC 1 min	1.7 × U_R + 1000 V, 50 Hz 0.1 sec each hour*
IEC 65	2000 V 50 Hz 1 min Surge: 50 discharges from 1 nF capacitor charged to 10 kV	500 V 50 Hz + 100 V 50 Hz 0.1 sec each hour 1500 hours*
UL 1414		
Across-the-line	120 V, 60 Hz + 5 kV surge 50 discharges from 1 nF capacitor charged to 10 kV	220 or 440 VAC 0,1 sec ea
Antenna coupling and line-by-pass		220

- * figure 1
- ** figure 2

166

RIFA

INTERFERENCE SUPPRESSORS
General Technical information

Figure 1. Endurance test
According to IEC 384-14 the capacitor shall be connected to a 220 Ω resistor during the 1000 V period.

During an IEC-65 test no resistor shall be used.

During 1985 some countries will make decisions of not using any resistor.

Figure 2. Surge voltage test
According to SEV:
Up for X cap = 3 kV
Up for Y cap = 5 kV
According to VDE and IEC 384-14
Up for X1 cap = 4 kV

Figure 3. Charge-discharge test.
According to VDE 0565/1 the capacitors shall be tested 10000 pulses at 100 V/us and √2 × U.. for PHE 800 and PHE 810.

RIFA tests the capacitors with metallized paper as dielectric 10 times the specified values in the article tables. 10000 pulses and X capacitors 630 VDC. IEC 65 and Y capacitors 1000 VDC

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CIRCLE NO 163

***Cadmium/mercuric-oxide alkaline batteries rated at 3.4 Ahr** (Rayovac Corp)*

Batteries function in high-temperature environments

Peter Harold, *European Editor*

You can now choose from a variety of battery chemistries that can extend the operating-temperature range of battery-powered equipment to well above 100° C. By employing solid-state materials, some of these batteries can operate at 200° C without risk of venting or explosion.

You can now add batteries to the list of components suitable for operation at elevated temperatures. Various battery types currently appearing on the market deliver useful power at temperatures in excess of 100°C. These parts range from small pc-board-mounting batteries for memory-backup applications to DD-size batteries with capacities as high as 22 Ahr. They allow electronic equipment to function in stand-alone mode in environments that would previously have required power cabling to remote power sources. But for the moment you can forget rechargeable batteries—even the best NiCd ones run out of steam well before they reach 100°C.

Most semiconductor devices and passive components are available as military-grade components specified for operation at temperatures as high as 125°C. Provided you're prepared to accept limited operational lifetimes, you can operate many of these components at temperatures well above this limit. As a result, you can design equipment that will operate in high-temperature envi-

Lithium/oxyhalide batteries rated for 150°C operation
(Electrochem Industries)

ronments—for example, in oil-well monitoring or engine- or reactor-testing applications. By including A/D conversion immediately behind the sensors, and by either transmitting acquired data digitally across a communications link or storing it in onboard RAM, you can drastically simplify the cabling requirements and reduce the noise problems associated with the use of remote analog sensors.

Although you can often remotely power these systems along umbilical cabling, you may need to provide the system with battery backup so that it can continue to function, or at least retain previously accumulated data, in the event of cable damage or disconnection. This consideration is of special importance where the cost of rerunning test operations is high—for example, in down-hole oil-well monitoring.

Until recently, however, batteries able to provide such backup have been unavailable for equipment required to operate at temperatures much above 100°C. Conventional batteries usually use wet electrolytes, which, at high temperatures, produce gaseous by-products. These gases increase the internal pressure of the battery. At best, the battery deforms to contain the pressure or vents to relieve it. At worst, it explodes. Either way, the useful power output of the battery is destroyed.

Recent developments in electrolyte chemistry have extended the current upper temperature limit of wet-electrolyte batteries to around 175°C. However, some manufacturers base their high-temperature batteries entirely on solid-state chemistries. These solid-state batteries don't produce gaseous by-products, so the risk of venting or explosion occurs at the higher temperatures at which the cell materials melt. (Lithium, for example, melts at around 180°C unless it's alloyed with other metals.) One disadvantage of solid-state batteries, however, is that their internal impedance tends to be higher than that of wet-electrolyte types. As a result, solid-state batteries have limited current ratings, so you need to choose them with care to ensure that they'll suit your application.

When choosing a battery for a high-temperature memory-backup application, bear in mind that self-discharge rates are considerably higher at elevated temperatures than at room temperature. For lithium batteries, which are usually regarded as having extremely long shelf lives, capacity losses due to self-discharge of around 20% per annum at a temperature of 100°C are not uncommon. As a result, you'll need to use batteries that have what appears to be a considerable degree of excess capacity if you're expecting them to operate at high temperatures for long periods.

Solid-state batteries suit memory backup

Catalyst Research's lithium/iodine batteries are suitable for CMOS RAM backup over the military temperature range (−55 to +125°C). Designated the µPowerCell Series, these batteries utilize solid-state anode, cathode, and electrolyte materials, thereby eliminating gas generation and appreciable volumetric change during discharge, and allowing the use of hermetically sealed, stainless-steel encapsulations with glass compression seals. This type of construction not only protects the batteries from harsh environmental conditions (for example, corrosive atmospheres), but also eliminates the possibility of explosion at temperatures below 250°C. In addition, the lithium-iodide electrolyte, which forms at the interface between the solid-iodine cathode and the lithium anode, is self-healing, so the batteries don't exhibit separator failure.

All the μPowerCell batteries have an open-circuit voltage of 2.8V. As long as you design the supply-changeover circuitry to minimize voltage drops, you can satisfy the 2V minimum data-retention requirements of most CMOS static RAMs with just one of these batteries. However, the batteries are restricted to very-low-current applications, because their internal impedance restricts the available current to a few tens or hundreds of microamps. Their high internal impedance does mean, however, that the batteries are self-protecting against reverse currents, short circuits, and similar electrical abuse.

The apparent current limitation of these batteries doesn't mean that they'll fail to supply the higher data-retention currents required by CMOS RAMs at high temperatures. In fact, both the electrochemical reactions within the battery and the leakage currents that constitute the major part of a static RAM's standby supply current increase with temperature at a similar rate. As a result, the available current from the batteries tends to track the CMOS RAM's requirements as the temperature rises or falls. If your operating temperature is above 50°C, you can float-charge μPowerCell batteries (at typically 1 μA) to compensate for their self-discharge, thereby extending their operating lifetime. In general, however, you should *never* float-charge a primary-cell battery without the consent of the battery manufacturer.

Because a battery's self-discharge rate increases with temperature, you'll have to design extra capacity into supplies that power CMOS RAM for extended periods.

μPowerCells are available in two case styles. The smaller one, the Automatically Insertable model, is a 35-mAhr, axial-leaded battery that's 0.4 in. long and 0.16 in. in diameter. It costs $2.94 (1000). At 25°C, this battery can supply 10 μA of constant current at a voltage greater than 2.0V. Supplied on reels of tape, it's suitable for use with automatic insertion equipment and capable of withstanding wave soldering. This suitability for automated assembly methods, coupled with the battery's inherent short-circuit protection, will allow your production department to treat these batteries like most other pc-board-mountable components.

The second case style, the Rectilinear μPowerCell, is available in 400-, 600-, and 1000-mAhr versions with low-profile (0.28-in.) rectangular pc-board footprints of 0.5×1 in., 0.7×1 in., and 1×1 in., respectively. At 25°C, these batteries, which sell for between $4.78 and $5.27 (1000), are capable of delivering a constant current of 50 μA at voltages above 2.0V, and maximum currents of 500, 800, and 1000 μA, respectively.

Coin- and button-cell batteries capable of continuously delivering tens of milliamps at 150°C *(Eveready Battery Co Inc)*

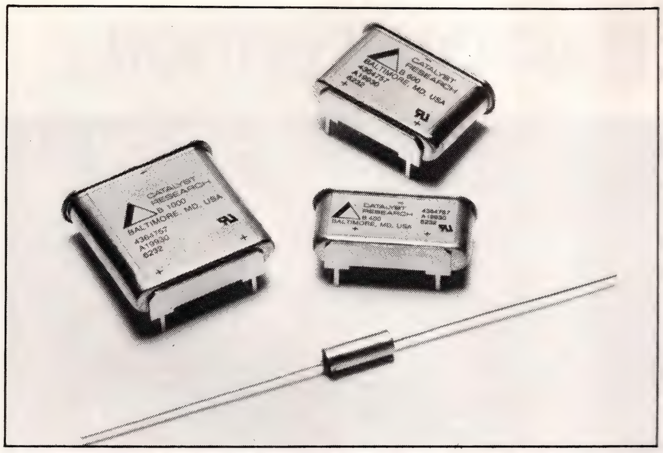
The company also produces −55 to +125°C, hermetically sealed lithium/iodine batteries in circular, low-profile, pc-board-mounting nickel cases. Available in 200-, 400-, and 650-mAhr versions with respective diameters of 0.782, 1.065, and 1.356 in., these batteries have two or three (one positive and two negative) pins in their baseplate that you can insert directly into a pc board. They range in price from $4.82 to $6.92 (1000).

Eveready Battery Co Inc's choice of chemistry for CMOS memory-backup applications is a lithium/titanium-disulphide battery. To achieve high-temperature operation, the battery utilizes true solid-state construction: It employs a vitreous inorganic electrolyte. As a result, the battery can have a useful operating-temperature range that extends to 200°C.

As with lithium/iodine batteries, the current available from lithium/titanium-disulphide batteries increases as temperature increases. However, lithium/titanium-disulphide batteries have a lower internal impedance than do lithium/iodine types, and at 150°C they can deliver continuous currents of several tens of milliamps. Instead of using these batteries for RAM backup, therefore, you might be able to use them to keep low-power circuitry active during a power failure. Note, however, that this capability might only apply at high temperatures: At normal temperatures the available current from these batteries falls to a few hundred microamps or less.

Secondary seal extends range

Eveready's lithium/titanium-disulphide batteries are available in a range of three 2.4V coin and button cells, rated for operation between −40 and +150°C, and as 2.4V and 4.8V batteries having a secondary encapsulation that extends their operating temperature range to 200°C. The XR1130 button-cell battery (11 mm in diameter×3 mm thick) has a capacity of 23 mAhr to an



Lithium/iodine batteries suitable for CMOS RAM backup in military-temperature-range equipment *(Catalyst Research)*

end voltage of 1.0V at 60°C with a 30-kΩ load. The XR2016 (20 mm in diameter×1.6 mm thick) and XR2025 (20 mm in diameter×2.5 mm thick) coin-cell batteries have respective capacities of 36 and 62 mAhr to an end voltage of 1.4V at 21°C with a 30-kΩ load.

In addition to their long-life, low-current capabilities, both the XR2016 and XR2025 have the ability to deliver pulse currents of several milliamps at normal ambient temperatures. At 21°C, they can sustain loads of 250 and 300Ω, respectively, while maintaining a terminal voltage of no less than 2V. These conditions correspond to respective pulse currents of 8 and 6.6 mA. All these coin- and button-cell batteries sell for around $20.

The batteries capable of operating to 200°C are the 2.4V XP4025 (its open-circuit voltage is 2.4 to 2.6V) and the 4.8V XP4050 (its open-circuit voltage is 4.8 to 5.2V). At 150°C and with a discharge current of 140 μA, the two batteries have capacities of approximately 95 and 40 mAhr, respectively. At 200°C, the 2.4V battery typically delivers 25 μA—which is the estimated standby current consumption of 256k bytes of CMOS static RAM at 200°C—for a period of 1650 hours before the terminal voltage drops below 2.0V. Under similar conditions, the 4.8V battery can deliver 25 μA for 1000 hours before the battery's terminal voltage falls below 4.0V. Both these batteries are housed in stainless-steel cases that measure 1×0.872×0.270 in., resemble typical crystal cans, and have both the positive and the negative terminal pins isolated from the battery case. These batteries are currently available as evaluation samples priced at $250 each.

Saft America Inc's high-temperature backup-battery offerings are the Dataguard-LDH Series, which is rated to 100°C, and the Dataguard-II Series, which is rated to 125°C. Both series use a lithium/copper-oxide chemistry and require a 2-cell stack to achieve their nominal terminal voltage of 3V. The Dataguard-LDH range includes 0.4-, 1.6-, and 3.6-Ahr batteries, all having a common diameter of 15.7 mm. Their respective lengths are 26.5, 51, and 101 mm. The Dataguard-II Series models are slightly larger; they achieve their higher temperature rating by employing polycarbonate encapsulations, rather than ABS-plastic ones. Both series have leads that make them suitable for pc-board mounting. The 1.6-Ahr versions of the Dataguard-LDH and the Dataguard-II sell for around $5 to $6 (5000).

If, instead of requiring memory backup, you need your equipment to remain operational from its battery pack, you'll have to select batteries that have considerably greater current capabilities. Electrochem Industries, which specializes in the production of batteries for use in the oil, mining, and geological-survey industries, offers a range of standard-size batteries that are capable of delivering several hundreds of milliamps at temperatures as high as 150°C.

These 3.8V batteries, the Performaxx RMM-150 Series, utilize lithium/oxyhalide chemistry and are available in AA, C, and D sizes. At 150°C, the AA size has a capacity of 1.3 Ahr at a rated discharge current of 20 mA, the C size offers 5.1 Ahr at 50 mA, and the D size specs 12 Ahr at 100 mA. The maximum continuous current available from the batteries is 150 mA, 500 mA, and 1A, respectively. A DD-size battery with a capacity of 22 Ahr is currently in the prototype stage. Each of these batteries features an integral safety fuse, incorporated beneath the terminal cap, that will render the battery inoperative in the event of an external short circuit. The RMM-150 Series batteries cost $32.25 for the AA, $34.65 for the C, and $41.60 for the D size. The manufacturer expects to sell the DD size for $54.25.

Solid-state batteries suit memory-backup applications, but use more conventional batteries to keep equipment operational at high temperatures.

Rayovac Corp's Cad-Merc-3000HC cadmium/mercuric-oxide battery, which is priced at around $8.50 (1000), has a nominal voltage of 0.95V, so you'd have to stack three or more of these batteries in series to satisfy the power-supply requirements of typical electronic circuitry. However, the 1.465-in.-diameter, 0.43-in.-thick coin cell has a nominal capacity of 3.4 Ahr and is rated to deliver an average current of 27 mA for a period of 130 hours before its terminal voltage falls below 0.6V. Typical discharge curves for this battery (with an average discharge current of 8.7 mA, 100Ω load per cell) show discharge periods (to 0.6V) of between 375 and 400 hours over an operational temperature range of approximately −18 to +125°C. Only at lower temperatures does this discharge period begin to shorten appre-

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CIRCLE NO 107

ciably (to around 200 hours at −40°C). Storage losses amount to less than 1% per year at 21°C and less than 1.5% per month at 71°C.

Saft produces the LC Series of 1.5V lithium/copper-oxide batteries in ¼AA, ½AA, and AA sizes, with nominal 20°C capacities of 0.4, 1.6, and 3.6 Ahr, respectively, for a discharge rate of 1 mA and an end voltage of 0.9V. The C-size battery is rated at 10 Ahr for a 40-mA drain, and the D size is rated at 20 Ahr for a 100-mA drain; both spec an end voltage of 0.9V. Although the ¼AA, ½AA, and AA sizes are normally rated for −40 to +70°C operation, and the C and D sizes for −40 to +60°C operation, all the batteries are available with custom encapsulations that increase their upper limit to 135°C.

For higher temperatures, consider Saft's LCP-HT 2.5V lithium/copper-oxyphosphate batteries, which are available in ½AA, AA, and C sizes with nominal capacities of 0.8, 1.9, and 5 Ahr, respectively. The AA version sells for around $25; the C version costs around $50 (1000). Although these batteries operate to 175°C, their low-temperature operational capability is limited to temperatures above 0°C, so they're not suitable for applications that encounter extremes of temperature. At temperatures above 100°C, the AA-size battery can deliver currents of around 100 mA at 2V for one or two hours, and at currents of less than 20 mA, the battery will maintain its voltage above 2V for well over 100 hours. Because of its lower surface area of lithium, the ½AA battery has approximately 0.4 times the discharge-rate capability of the AA-size.

> *Although silver and mercury cells are suitable for high-temperature environments, lithium batteries still dominate that sector of the market.*

Varta Batteries Inc produces two batteries for high-current, high-temperature applications: a silver-oxide battery that can operate to 165°C and a silver-cadmium battery that can operate to 200°C. The 4016 silver-oxide battery is a 1.5V, C-size battery with a capacity of 3 Ahr at 165°C, a discharge current of 200 mA, and an end voltage of 0.9V. Increasing the discharge current to 400 mA reduces this capacity to around 2.4 Ahr. The 4016 costs approximately $60 (1000). The 4017 1.15V silver-cadmium battery, which is currently available only in sample quantities, has a nominal capacity of 3 Ahr, at a discharge rate of 400 mA, and to an end voltage of 0.8V. It can withstand an operating temperature of 200°C for a period of six weeks.

Finally, if you don't like the prospect of handling off-the-shelf individual batteries, you'll be pleased to know that most of the companies mentioned here—especially those that offer high-current batteries—can supply you with custom battery packs. These battery packs typically contain several cells wired in series or in parallel to suit your voltage and current requirements, and are encapsulated in materials such as stainless steel, fiberglass, or epoxy resin. While assembling these battery packs, the manufacturers can incorporate diodes to prevent discharge paths between cells connected in parallel, or to prevent excessive reverse voltage across series-connected cells. **EDN**

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478

For more information . . .

For more information on the high-temperature batteries discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Catalyst Research
1421 Clarkview Rd
Baltimore, MD 21209
(301) 296-7000
TLX 898095
Circle No 533

Electrochem Industries
10000 Wehrle Dr
Clarence, NY 14031
(716) 759-2828
TLX 91386
Circle No 534

Eveready Battery Co Inc
39 Old Ridgebury Rd
Danbury, CT 06817
(203) 794-7467
Circle No 535

Rayovac Corp
601 Rayovac Dr
Madison, WI 53711
(608) 275-3340
TLX 190428
Circle No 536

Saft America Inc
107 Beaver Ct
Cockeysville, MD 21030
(301) 771-3200
Circle No 537

Saft France
125 rue du President Wilson
92302 Levallois Perret
France
(1) 47393268
TLX 630085
Circle No 538

Varta Batteries Inc
300 Executive Blvd
Elmsford, NY 10523
(914) 592-2500
TLX 6931124
Circle No 539

Varta Batterie AG
Am Leineufer 51
3000 Hannover 21
West Germany
(0511) 79031
TLX 921175
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Germanium Rectifiers: Oliver gives you the facts.

Device	Peak Vf at 1000A	Rel. Eff. % at 5kW output	Input V at 1000A	Relative dc ripple mV
Germanium	**0.60**	**86.5**	**188.8**	**80**
Schottky	**1.00**	**85.0**	**190.0**	**150**
Silicon A	**1.20**	**76.0**	**200.0**	**100**
Silicon B	**1.25**	**74.0**	**202.0**	**95**

"The more we study Rectification," says Oliver O Ward, President GPD and sometimes known as the Professor of Germanium, "the more we see that Silicon is clearly the outdated technology.

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"The figures in the table come from field and laboratory tests carried out by one of the world's leading computer manufacturers. This company now uses Germanium rectifiers both in mainframes and in separate power supplies. Germanium is also the recommended technology for linear power supplies and for rectification in many circuits.

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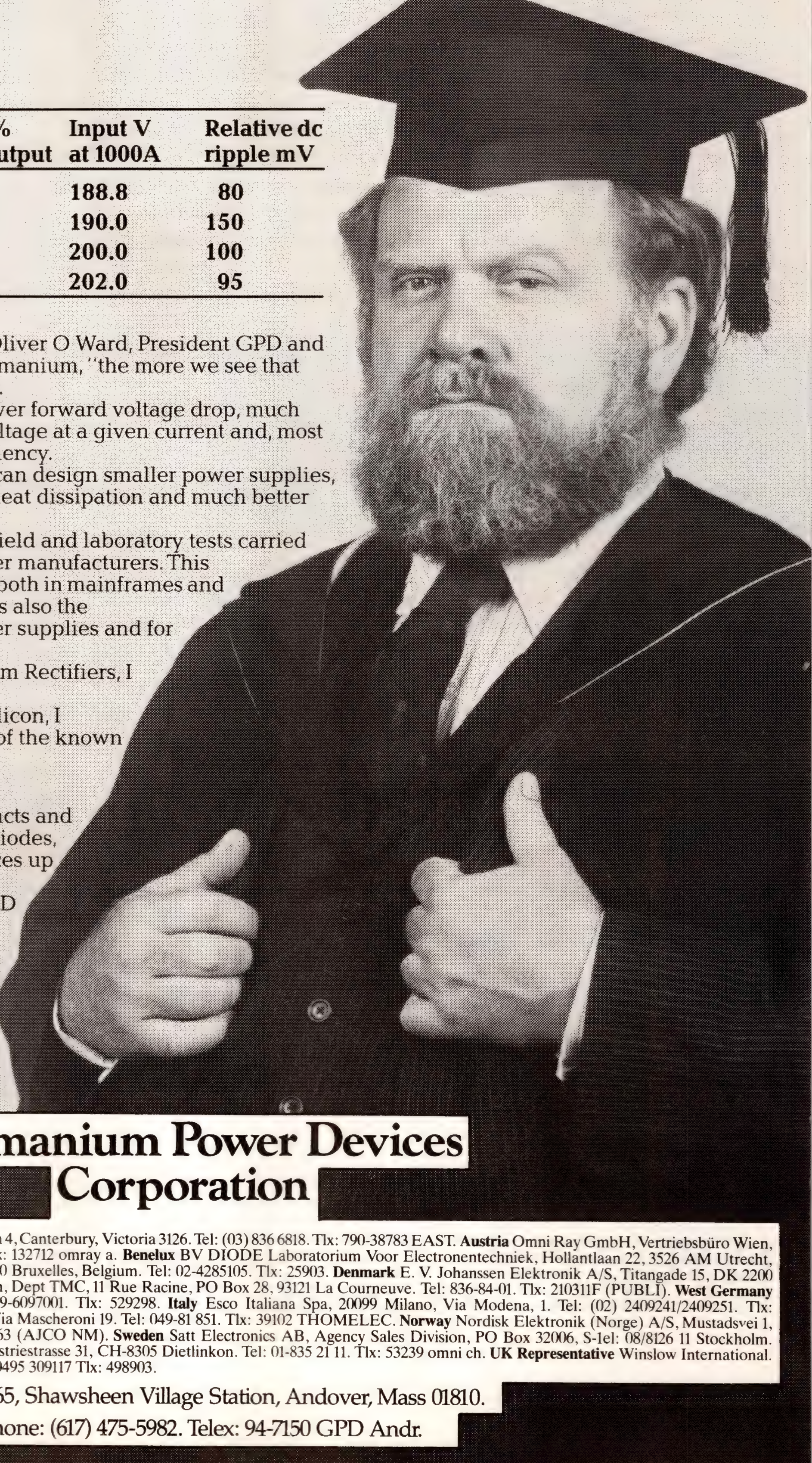
"To those still using old-fashioned Silicon, I respectfully suggest a careful re-reading of the known facts."



The latest GPD Catalogue contains facts and figures on Germanium Rectifiers, Photo Diodes, Small Signal Transistors and Power Devices up to 500A; all combining the inherent advantages of Ge technology with the GPD high standard of manufacture. Write, telephone or use the enquiry service.

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Germanium Power Devices Corporation

Australia Eastern Crest (Pty) Ltd., 21 Shierlaw Avenue, Room 4, Canterbury, Victoria 3126. Tel: (03) 836 6818. Tlx: 790-38783 EAST. **Austria** Omni Ray GmbH, Vertriebsbüro Wien, Prinz Eugen-Strasse 36, A-1040 Wien. Tel: 0222-65 64 31. Tlx: 132712 omray a. **Benelux** BV DIODE Laboratorium Voor Electronentechniek, Hollantlaan 22, 3526 AM Utrecht, Holland. Tel: 030-884214. Tlx: 47388/Rue Picard Str. 202, 1020 Bruxelles, Belgium. Tel: 02-4285105. Tlx: 25903. **Denmark** E. V. Johanssen Elektronik A/S, Titangade 15, DK 2200 Copenhagen N. Tel: 0451-83 90 22. Tlx: 16522. **France** Davum, Dept TMC, 11 Rue Racine, PO Box 28, 93121 La Courneuve. Tel: 836-84-01. Tlx: 210311F (PUBLI). **West Germany** Protec GmbH. Margreider Platz D8012 Ottobrun. Tel: 089-6097001. Tlx: 529298. **Italy** Esco Italiana Spa, 20099 Milano, Via Modena, 1. Tel: (02) 2409241/2409251. Tlx: ESCOMI 322383./Eurelettronica SrL, Sede, 20145 Milano, Via Mascheroni 19. Tel: 049-81 851. Tlx: 39102 THOMELEC. **Norway** Nordisk Elektronik (Norge) A/S, Mustadsvei 1, Postboks 91-Lilleaker, Oslo 2. Tel: 0752-13300. Tlx: 856-16963 (AJCO NM). **Sweden** Satt Electronics AB, Agency Sales Division, PO Box 32006, S-1el: 08/8126 11 Stockholm. Tel: 08/81 01 00. Tlx: 10884. **Switzerland** Omni Ray AG, Industriestrasse 31, CH-8305 Dietlinkon. Tel: 01-835 21 11. Tlx: 53239 omni ch. **UK Representative** Winslow International. Rassau Industrial Estate, Ebbw Vale, Gwent NP3 5SD. Tel: 0495 309117 Tlx: 498903.

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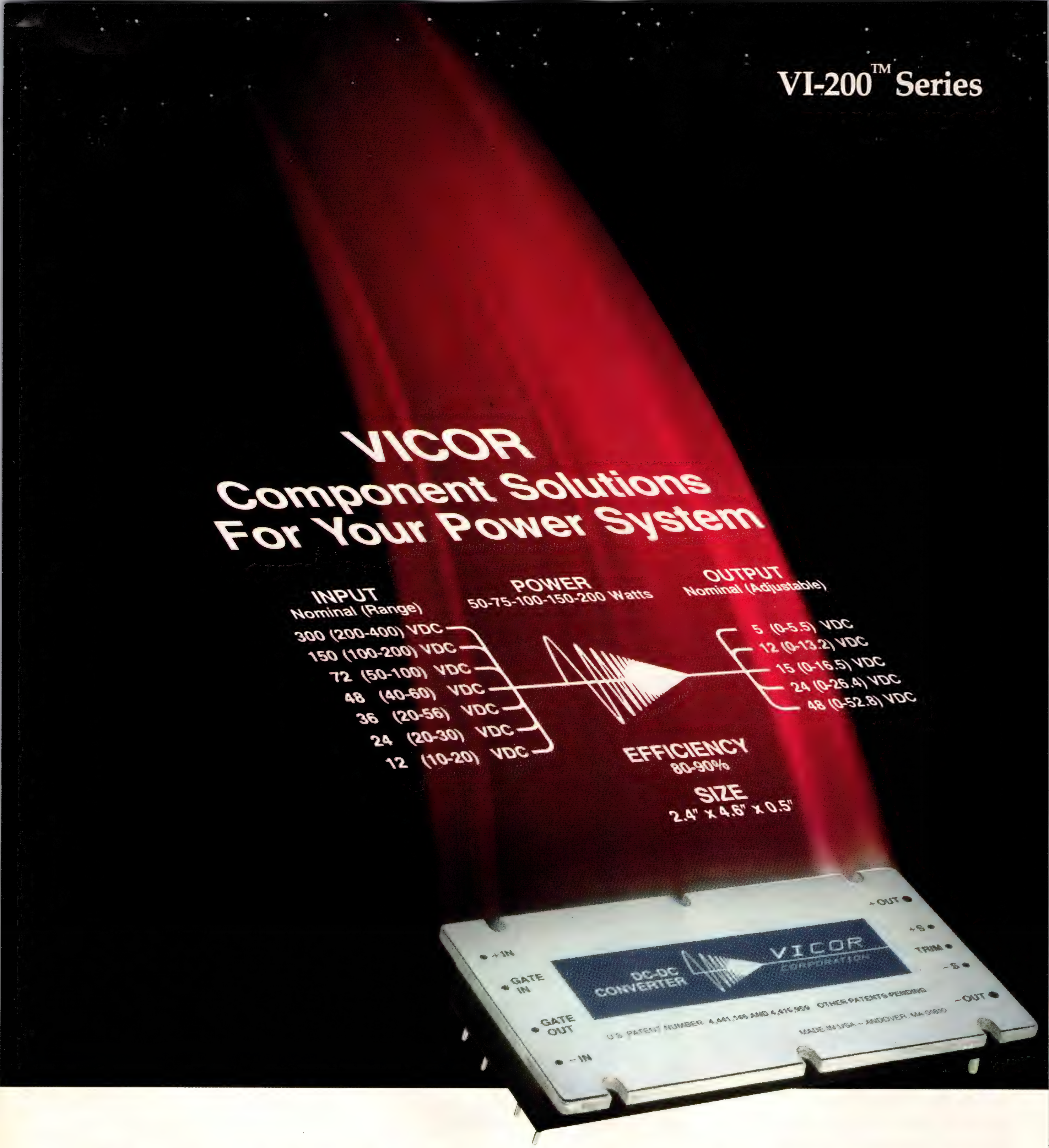

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Multiple-output switcher adjusts input power according to load requirements

The Wattbox LFQ series of switching power supplies includes six models in three package sizes. Each of the supplies' individual outputs senses the current level of its loads. To maximize efficiency, each supply then adjusts the input power applied to each output's regulator. Each supply provides the following outputs: one 5V output, two bipolar 12 to 15V adjustable outputs, and either one 24 to 28V adjustable output or a second 5V output. All the outputs are isolated. The series' maximum output power ranges from 325 to 635W.

The supplies incorporate surface-mount components and the firm's pulse-width-modulation control circuits. According to the vendor, the series eliminates the need for stocking different custom units to provide a range of wattages for the same voltage outputs. Further, the supplies can accommodate minor design upgrades without modification. From $325.

Lambda Electronics, 515 Broad Hollow Rd, Melville, NY 11747. Phone (516) 694-4200.

Circle No 525

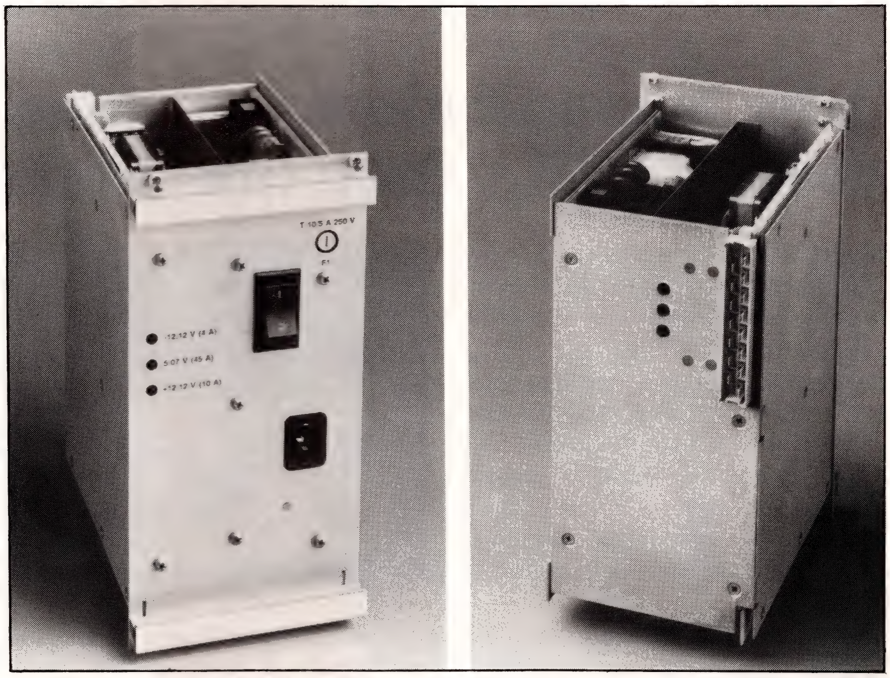
400W, VME Bus switching power supply plugs directly into mother board

The Model H4ACL051212 triple-output switcher plugs directly into a VME Bus backplane via a DIN-1494 15A spade-lug connector; you provide ac power through a front-panel, 3-prong power jack.

The supply conforms both to Eurocard packaging standards as defined in DIN-41494 and to IEC-297 standards for direct plug-in to the mother board.

The 400W unit provides 5V at 45A, +12V at 10A, and −12V at 4A. The line and load regulation spec ±0.4%; ripple and noise are 1.0% p-p max. The supply accepts 120 or 240V ac at 49 to 61 Hz.

The supply has overvoltage protection on its main output and current limiting on all its outputs. Its front panel sports "power-OK" LEDs for each output.

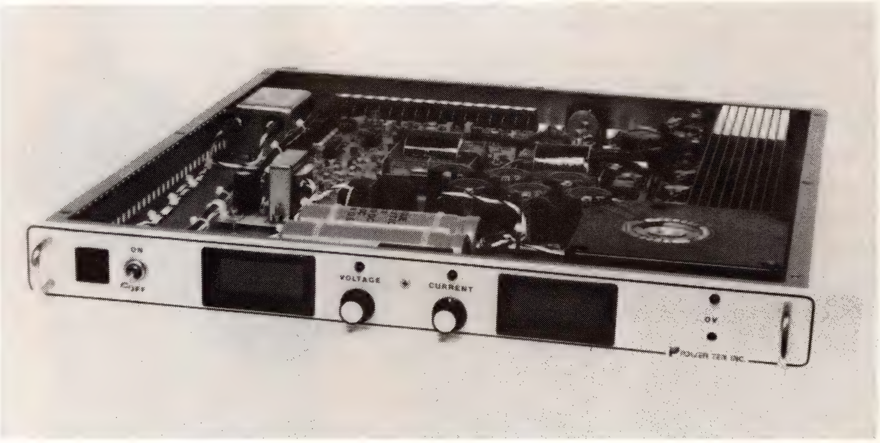


The supply features remote sensing for the main output, remote enable, and a TTL output-OK signal. It meets applicable EMI and safety regulations of UL, CSA, FCC, and TUV (VDE). Model H4ACL051212 costs $753.

NCR Corp, 3200 Lake Emma Rd, Lake Mary, FL 32746. Phone (305) 323-9250.

Circle No 528

Rack-mount supply compresses 1000W unit into 1¾-in. chassis



The Series 3300 rack-mounted power supplies fit into a 1¾-in.-high chassis yet provide as much as 1000W output. Their output voltages range from 0 to 7.5V dc to 0 to 60V dc. The output currents range from 125A for the low-voltage models to 10A for the high-voltage models. The supplies operate from single-phase power—either 95 to 127V ac or 190 to 253V ac (at 47 to 63 Hz). The supplies operate over 0 to 50°C. Each unit has its own internal fan and weighs 15 lbs.

The power supplies offer line and load regulation of 0.1% of output for both voltage and current. The quoted transient response for a 30% step change in load is 2% recovery within 10 msec. Given constant line, load, and temperature levels, the unit has 8-hour stability of ±0.05%.

The supplies have overvoltage, overcurrent, overtemperature, and brownout protection. The units' front panels incorporate digital voltmeters and ammeters, as well as LEDs that show when protection circuitry is in effect.

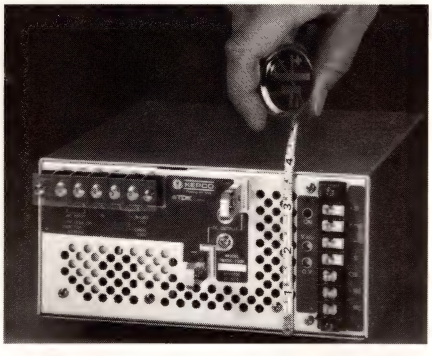
The supplies feature inrush-current limiting and slow-start mode. Remote shutdown is standard. Optional features allow you to operate the units in parallel or in series. Prices range from $775 to $950 depending on model. Delivery, stock to six weeks ARO.

Power Ten Inc, 486 Mercury Dr, Sunnyvale, CA 94086. Phone (408) 738-5959.

Circle No 527

Telecommunications switching supply delivers 12.5A from low-profile package

Model RBX 48-12.5K is a 66W switcher that suits 48V dc telecommunications applications. The 150-kHz switcher delivers as much as 12.5A from a package that measures 3¾×7⅞×8⅝ in. The manufacturer claims that the supply runs at 85% efficiency (at full load). It accepts either 85 to 132V ac or 170 to 264V ac (at 47 to 66 Hz). You can adjust the output over the range of 38.4 to 52.8V dc.



The units have 200 mV max p-p ripple; voltage spikes are <500 mV. The holdup time is 20 msec min, and the brownout voltage is either 80 or 160V ac, depending on the input tap you select. The main output recovers from a 50% load change within 300 μsec, with a 4% overshoot. You can parallel as many as three units (with 10% derating).

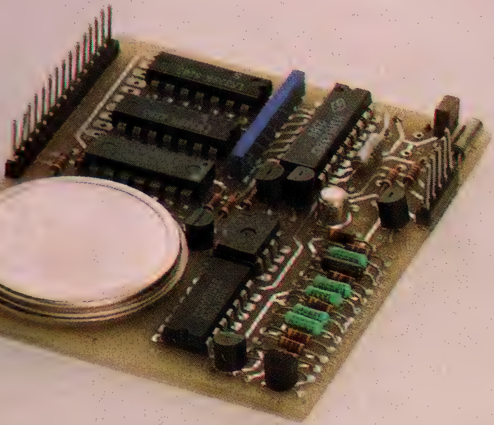
The supply has overvoltage, undervoltage, and overcurrent protection. The overcurrent protection will automatically reset 20 sec after the overload clears. If the unit's fan fails, the supply will shut down. The unit features remote voltage and on/off control. The supply's panel has an "output-OK" LED.

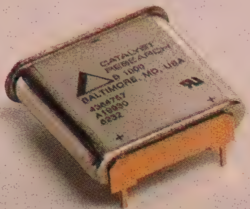
The supply weighs 9.25 lbs. It has a built-in cooling fan. The unit meets UL 478 and CSA C22.2-154 safety standards; voltage isolation is 2 kV for 1 minute applied to chassis as well as 2 kV for 1 minute input-to-output. Model RBX 48-12.5K costs $675.

Kepco Inc, 131-38 Sanford Ave, Flushing, NY 11352. Phone (212) 461-7000. TWX 710-582-2631.

Circle No 526

Remember when backup battery assembly was like putting a round peg in a square hole?





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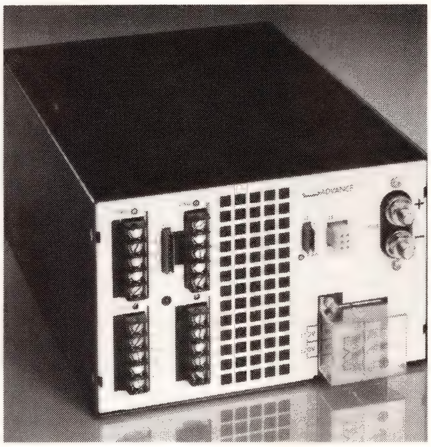
CIRCLE NO 114

Power Sources

1-kW switchmode supply features as many as five outputs

You can add as many as four auxiliary outputs to the P1000 switchmode power supply, which is capable of delivering a total output power of 1 kW. The main output delivers 5V at 150A. You can choose from a range of auxiliary outputs, including 5V or 12V outputs at 15A, a 24V output at 8A, and a 48V output at 5A. All the outputs have remote-sensing capability, which compensates for cabling voltage drops of 0.5V.



The power supply can operate from ac line supplies in the 88 to 132V or 176 to 264V range; you select the range via a link pin. The supply accepts line frequencies from 47 to 440 Hz, and its peak inrush current at power-on is less than 30A. All the outputs remain within regulation for at least 30 msec after nominal ac line voltage (110 or 220V) is removed.

The outputs are protected by constant current limits, and the entire supply is protected against overtemperature conditions.

The P1000 is housed in a 5×8×11-in. fan-cooled enclosure, and it operates over 0 to 70°C. It meets UL, CSA, BS, and VDE safety requirements. A unit providing only the main output costs £620; auxiliary outputs add about £60 each.

Advance Power Supplies Ltd,
Raynham Rd, Bishop's Stortford,
Herts CM23 5PF, UK. Phone
(0279) 55155. TLX 81510.

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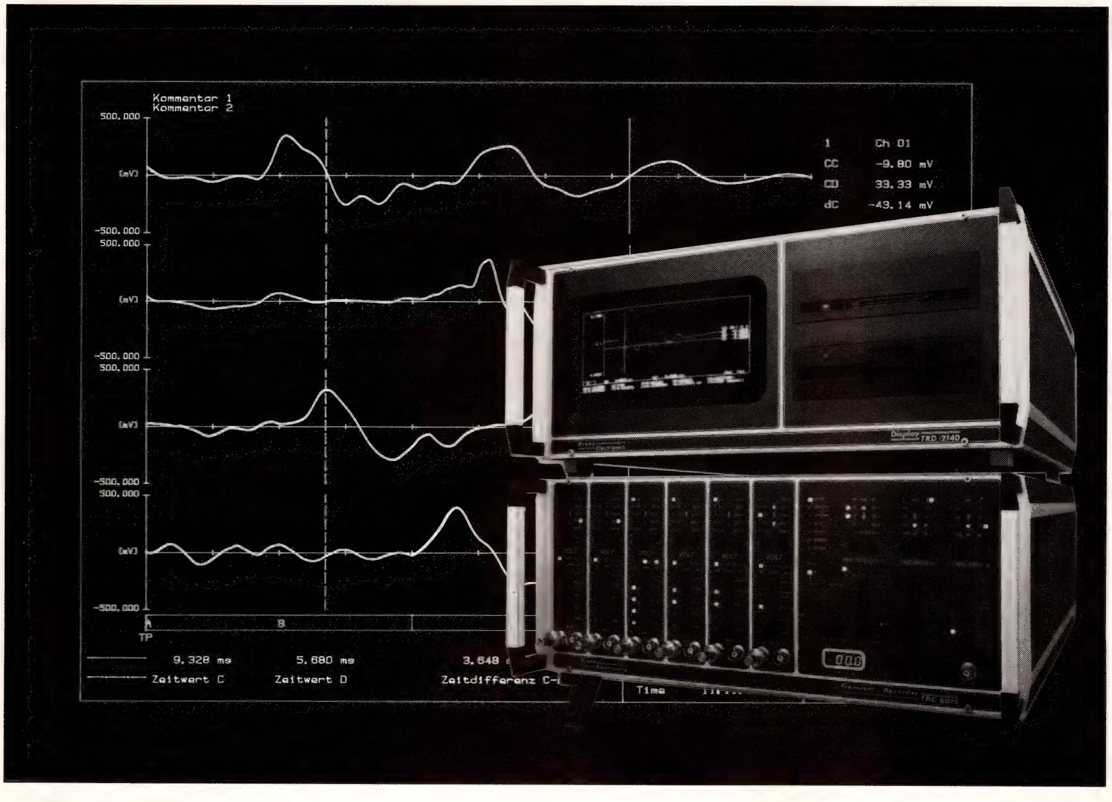

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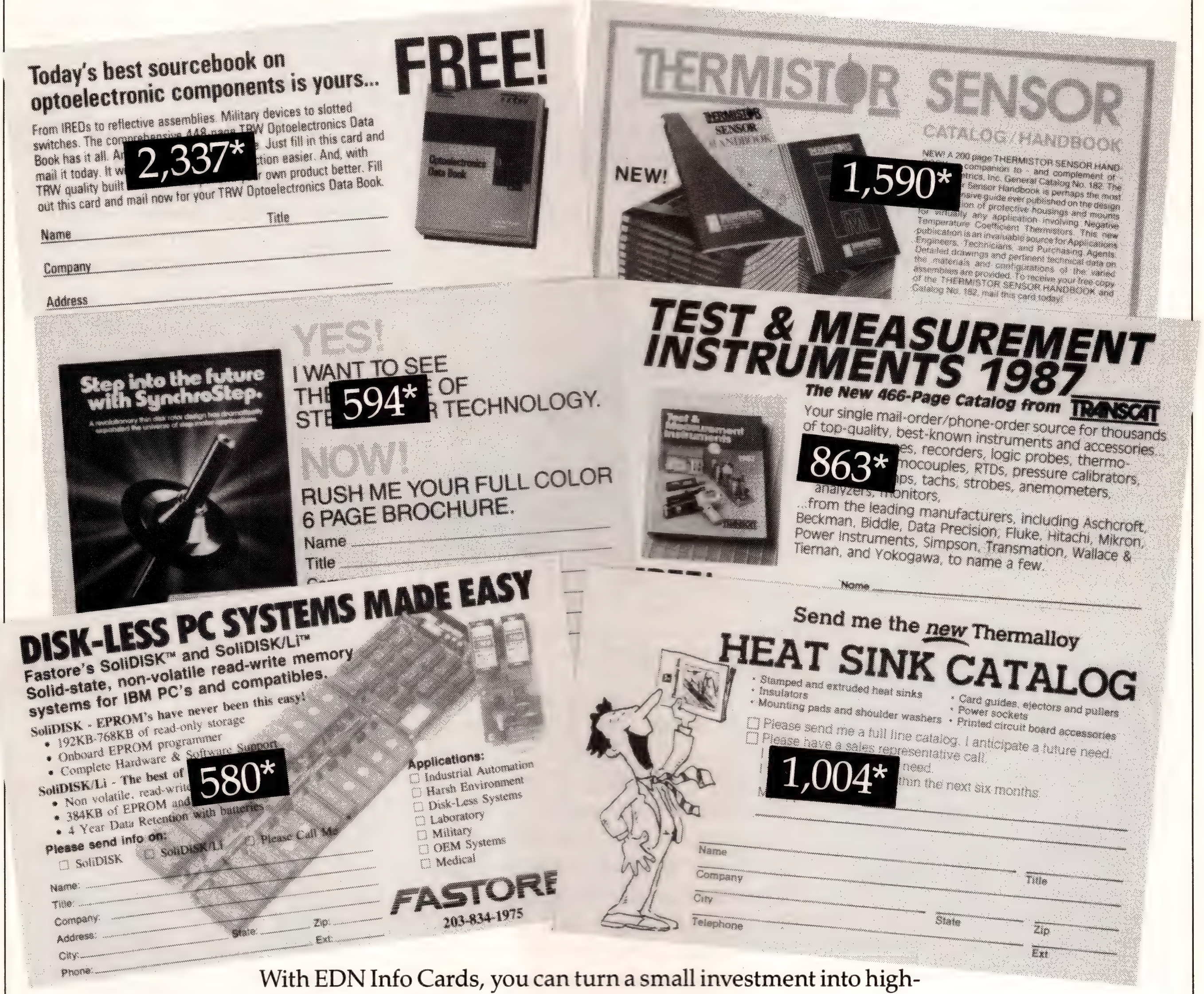

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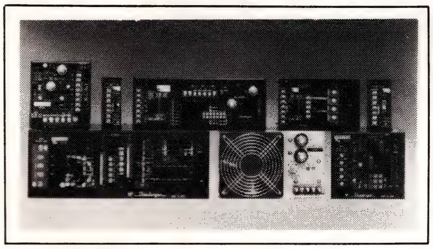
CIRCLE NO 123

Power Sources

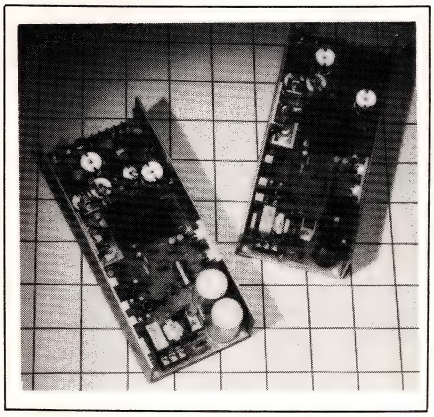


SWITCHER SERIES

The SY/G and EYG/G Series closed- and open-frame switching power supplies have a field-failure rate of <0.01% (>300,000-hour MTBF), the manufacturer claims. The switchers offer output voltages ranging from 2 to 69V. The open-frame models generate 15 to 160W; the closed-frame models' capacities range from 25 to 2250W. Some of the models meet national and international standards. SY/G Series, \$109 to \$485 (100); EYG/G, \$36 to \$47. Delivery, three to eight weeks.

Shindengen America Inc, 2649 Townsgate Rd, Suite 200, Westlake Village, CA 91361. Phone (805) 373-1130. FAX 805-373-3710.

Circle No 632

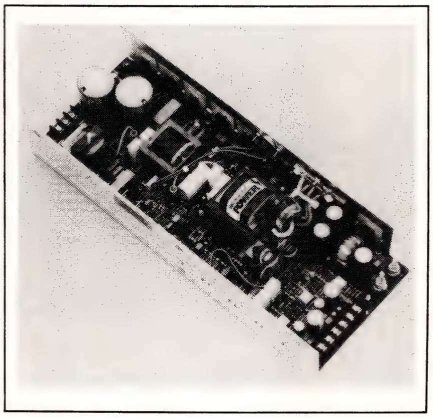


SWITCHING SUPPLIES

The Max-500 Series of multiple-output, open-frame switching supplies comprises 400 and 500W units. The supplies come in packages measuring 2.5×5×9.9 in. or 11.5 in. (depending on wattage). The supplies accept 90 to 132V ac or 180 to 264V ac at 47 to 63 Hz. They supply 5V at 55 to 70A and ±12V at 2A. An additional output supplies 12, 24, or −5.2V at 10A (16A pk). Their line and load regulation specs ±1%; ripple and noise are 0.2% rms, 1% p-p, or 100 mV max. They offer overload, overvoltage, and overtemperature protection. You can adjust all the outputs' voltages. The supplies meet UL, CSA, IEC, and VDE safety requirements and FCC and VDE EMI specs. All models have a remote-inhibit input and require 30 cfm of cooling air.

Todd Products Corp, 50 Emjay Blvd, Brentwood, NY 11717. Phone (516) 231-3366. TWX 510-227-4905.

Circle No 633

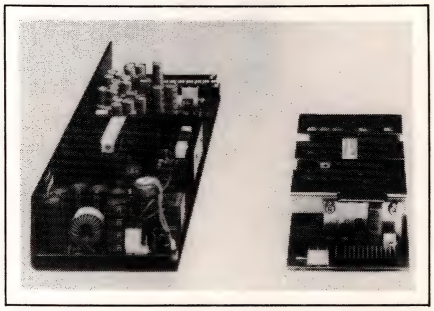


DISK SUPPLY

The XL325 triple-output switching power supply features floating auxiliary outputs that have high peak-current capability. The unit supplies 350W for as much as 1 minute. The main output provides 5V dc at 45A, and the two auxiliary outputs each provide 12V dc at 10A continuously (14A surge). All outputs are adjustable. You can wire the isolated auxiliary outputs in series or in parallel. The supply has overload protection on all outputs and overtemperature and overvoltage protection on the main output. The unit operates from 90 to 132V or 180 to 265V ac. It meets UL, CSA, and VDE safety specs and FCC and VDE EMI specs. Model XL325, \$349 (100).

Computer Products Inc, Power Conversion Group, 2900 Gateway Dr, Pompano Beach, FL 33069. Phone (305) 974-5500.

Circle No 635

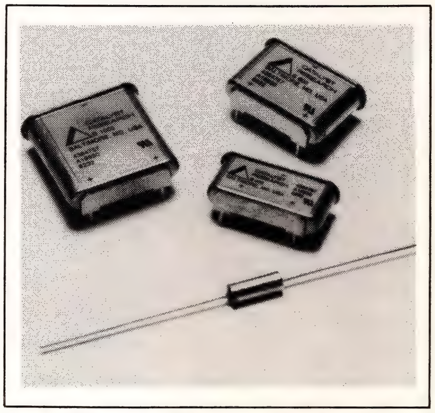


SAFE SUPPLIES

The WP Series multiple-output switchers accept input voltages ranging from 80 to 280V ac at 40 to 440 Hz without jumpers, straps, or switches. New safety specs that require a power supply to withstand being attached to the wrong line voltage mean that now this power-supply maker can offer a wide-range-input unit at a price that's not much more than that of a conventional, 2-range-input model with additional input-protection circuitry. The series comprises 35 models whose output-power specs range from 40 to 200W. The supplies feature 1% line and load regulation and 1% noise and ripple. Prices range from \$175 to \$353.

Conver Corp, 916 W Maude Ave, Sunnyvale, CA 94086. Phone (408) 739-9111. TWX 910-338-2036.

Circle No 634



BACKUP BATTERIES

The μPowerCell lithium-iodine batteries have a 2.8V output and are available in various capacities—1 Ahr (B-1000), 600 mAhr (B-600), and 400 mAhr (B-400). The batteries have a 20-year-min shelf life at

Three ways to tell the leader in linear power supplies from the losers.

The next time you start to think that all standard linear power supplies are equal, we suggest three tests that quickly separate the leader from the losers.

1 **The certification test.** Each of the twenty-four power supplies in the Condor Superior International Series meets the industry's most rigorous standards including international and UL 544 medical equipment certification. Other suppliers stop short.

2 **The computer test.** Every single unit in the Superior International Series is computer tested for performance. And we pack the printed test results with every unit. So you can see how they stack up with your own two eyes. Other companies ask you to take their word for it.

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When you put linear power supplies to the test you'll see that the Condor Superior International Linear Series has no equals. It gives you selection, precision and value. It even passes the test of immediate availability. For the source in your area call us toll-free today at 1-800-235-5929. In California, call (805) 486-4565.

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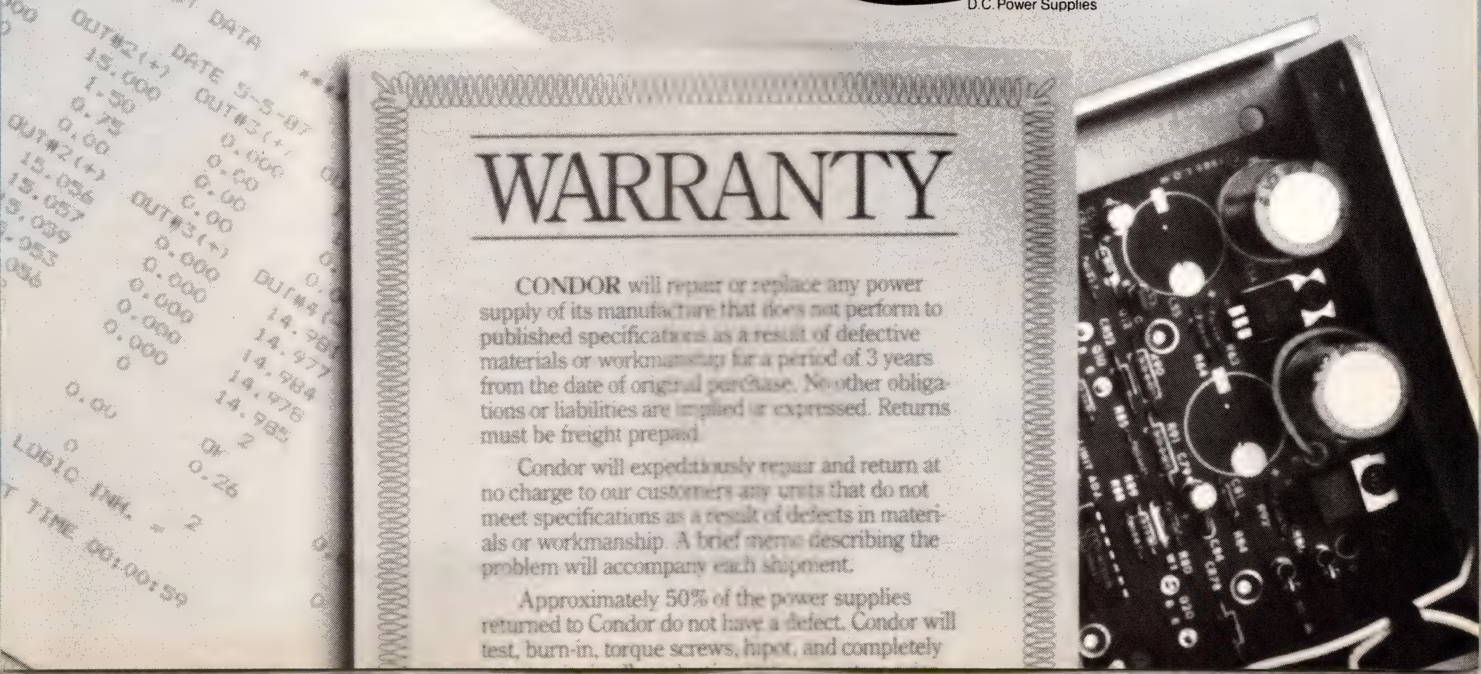

WARRANTY

CONDOR will repair or replace any power supply of its manufacture that does not perform to published specifications as a result of defective materials or workmanship for a period of 3 years from the date of original purchase. No other obligations or liabilities are implied or expressed. Returns must be freight prepaid.

Condor will expeditiously repair and return at no charge to our customers any units that do not meet specifications as a result of defects in materials or workmanship. A brief memo describing the problem will accompany each shipment.

Approximately 50% of the power supplies returned to Condor do not have a defect. Condor will test, burn-in, torque screws, hipot, and completely

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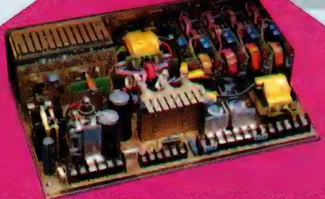
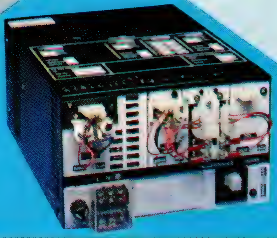
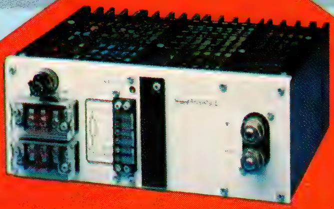
5/300 High Power — 5″ x 8″ x 11″ ■ 5V/300A/1500 watts ■ Built-in load sharing and paralleling circuit.



Powerflex — Up to 5 outputs ■ 500 watts continuous /750 watts surge ■ Inputs of 115/230 VAC or 48 VDC

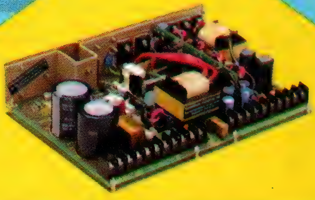


Hiflex — 5″ x 8″ x 11″ ■ Up to 6 independent outputs ■ To 1000 watts



MG — Demonstrated MTBF in excess of 125,000 hours ■ Single outputs from 5V-60V/100 watts to 500 watts ■ High-density convection cooled packaging

Multi High Power — 5″ x 8″ x 11″ ■ Mix and match up to 5 outputs ■ To 1000 watts



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The electronic systems you design are complicated enough without designing your own DC switching power supply — a system in itself. So go ahead. Do what you do best. And let Advance supply the power.

When designing around any one of the single- or multiple-output, open or closed Advance switching power supplies, you won't have to worry about compromising the overall quality of your product. These reliable switchers deliver from 180 to 1500 watts of full power in any voltage combination you may require.

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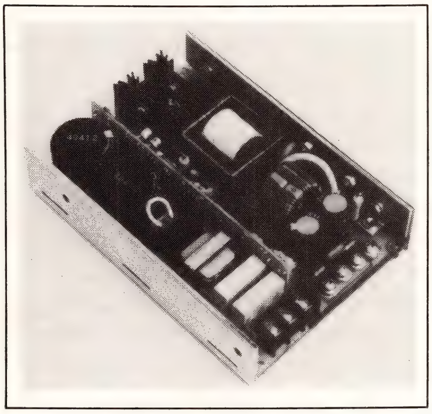
temperatures below 37°C. At temperatures above 50°C, you can use a float charge to extend battery life. Their useful operating range is −55 to +125°C.

The wave-solderable batteries are packaged in a hermetically sealed, stainless-steel case that is welded and insulated with glass compression seals around the negative lead. A current-limiting, high internal impedance eliminates the danger of explosion from reverse current, short circuit, or other electrical malfunctions. $3 to $6.

Catalyst Research Corp, 1421 Clarksview Rd, Baltimore, MD 21209. Phone (301) 296-7000.

Circle No 636

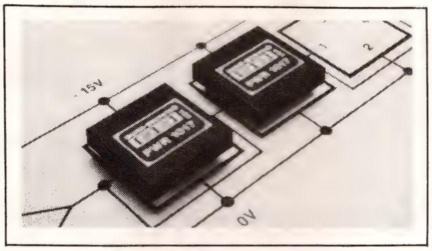


CONVECTION SUPPLIES

Enclosed in a 6×4.25×1.45-in. package, the convection-cooled LPS Series switching power supplies feature 100W output ratings. The supplies meet VDE0806, UL478, and CSA22.2 safety specs. The input sections have onboard EMI filters and accommodate either 110 or 220V ac. Standard features include soft start and current limiting. The units have a 20-msec hold-up time and ±0.5% total regulation on 5, 12, 15, and 24V outputs. A 2-stage output filter limits output ripple and noise to 1% p-p. Single-output units, $97.50 (100).

Integrated Power Designs Inc, 9 Princess Rd, Suite C, Lawrenceville, NJ 08648. Phone (609) 896-2122.

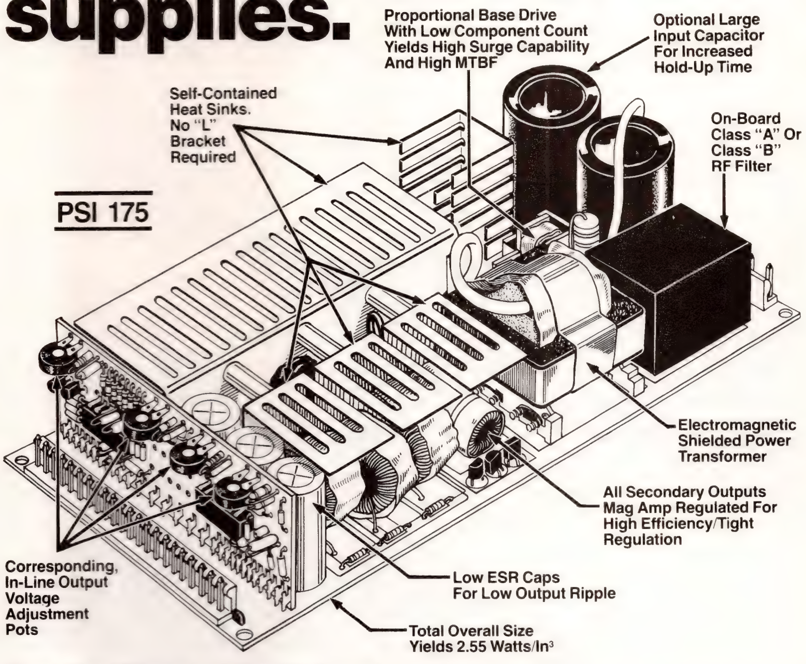
Circle No 637



DC/DC CONVERTER

The PWR1017 is a 4-channel, dual-output, unregulated dc/dc converter. It features a master/slave design to eliminate beat-frequency noise generated by multiple supplies in the same system. You can also drive the converter from an external clock. An input of 400 to 750 kHz drives the converter at a 200- to 350-kHz switching rate. The free-running switching frequency (no

PSI/STD...
Reconsider your concept of standard vs. custom power supplies.


Proportional Base Drive With Low Component Count Yields High Surge Capability And High MTBF
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Total Overall Size Yields 2.55 Watts/In³

Now The Choice is Really Yours.

PSI 175 . . . A significant advance in fully configured, multiple-output switching power supplies. And the versatility of the standard PSI 175 module with its available options enables you to obtain a "custom" power supply without the lead time or development costs associated with custom products.

PSI 175 . . . the 175-watt, convection-cooled, quad output power supply. Standard features with many applications: 115/230 VAC, 47-440 Hz, full power rating at 50°C . . . all in the smallest package available. Up to four fully regulated voltage combinations on all outputs. L- brackets for special mounting, and autoranging on input available, plus many other options.

If you previously required custom power supplies, it's time for you to reconsider your concept of standard switchers and specify PSI 175. And remember, if we're unable to meet your needs with a standard unit, we will do a custom design.

Write us today for detailed specifications, complete options, and prices.

Power Systems, Inc.

45 Griffin Road South, Bloomfield, CT 06002
(203) 726-1300 TWX: 710-425-8778
Fax: (203) 726-1495

CIRCLE NO 33

slave pins used) equals 250 kHz. The converter operates over a 10 to 18V dc input range; the output of each channnel equals ±15V at 25 mA. The maximum output power is 3W. Isolation between each output and from the input equals 1000V pk. Other key features include 6-sided shielding, input and output filtering, and a 0.4-in.-high package. $58.75 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 639

PC-BOARD CONVERTERS

The SA and SB Series isolated, pc-board-mountable dc/dc converters include single- and multiple-output models that operate from a 48V dc nominal input and develop 5.1V/3A (SA) and 5.1V/4.5A, 12V/1A, and −12V/1A (SB) outputs. The SA and SB units come in 6-sided metal cases that measure 2×2×0.43 in. and 3×3×0.43 in., respectively.

The converters feature 500V dc input-to-output isolation, 75% typ efficiency, and a 2,000,000-hour MTBF. The converters are convection cooled to operate over 0 to 60°C, and any output will provide as much as 50% of the total output power. $69 to $125 (OEM qty). Delivery, eight to 10 weeks ARO.

International Power Sources Inc, 10 Cochituate St, Natick, MA 01760. Phone (617) 651-1818. TWX 510-100-3630.

Circle No 638

VOLTAGE CONVERTER

The MAX680 dual charge-pump voltage converter provides positive and negative voltages from a single positive supply. It features 85% efficiency. The unit handles inputs of 2 to 6V dc and provides outputs of 2V and −2V, as well as 10 output-current ranges to 10 mA. Typical 10-mA-load output impedances range from 90Ω for the V^- output to 150Ω for the V^+ output. The quiescent-current level for a 5V input equals 1 mA.

The converter can also function as a voltage quadrupler, producing a 12 or −12V output when operating from an isolated 3V source. The unit

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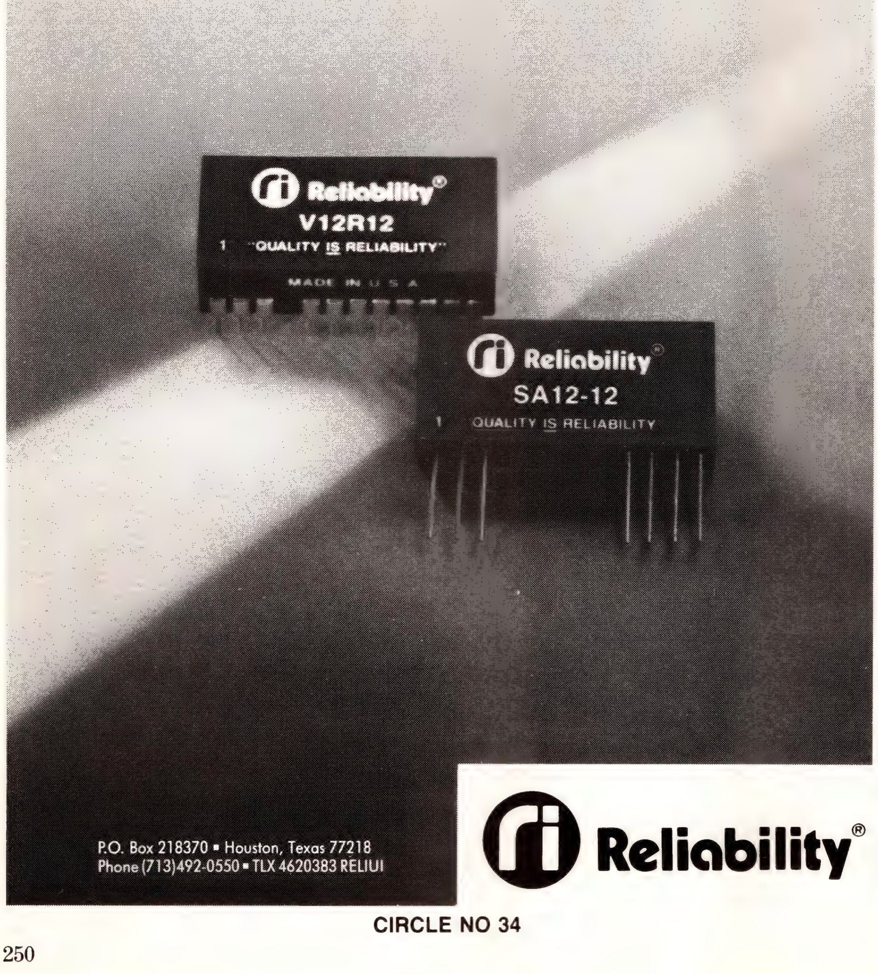

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CIRCLE NO 34

is available in plastic or ceramic 8-pin DIPs, or in an 8-pin small-outline package. Three operating ranges are offered: 0 to 70°C, −40 to +85°C, and −55 to +125°C. $2.16 to $4.32 (100).

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 640

STD SUPPLIES

Series 29 power supplies plug directly into STD Bus card-cage connectors. The supplies are available with inputs of 12, 24, and 48V dc and 120 and 240V ac. Standard outputs are 5V at 1.5A (to the STD logic Bus) and ±12V at 300 mA (to the STD auxiliary bus). An output of −5V at 250 mA is optional. All outputs feature overvoltage protection. The series' efficiency specs at 78% min. All models include a system-reset pushbutton, an on/off switch, and an LED power-on indicator. You can operate the supplies at temperatures as high as 80°C without derating. The boards come with either a flat-cable connector or a terminal block. $240. Delivery, stock to six weeks ARO.

Remote Systems Technology Inc, 1800 West Belt N, Houston, TX 77043. Phone (713) 932-9584. TLX 882267.

Circle No 641

DISK SUPPLY

Model 4501 powers hard-disk drives. Channels 1, 2, and 3 deliver 12V at 6A (12A pk), 5V at 6A, and −12V at 1A, respectively. The regulation specs at ±1% for channels 1 and 2 and ±3% for channel 3. The supply relies on convection cooling (no fans or blowers needed) and operates over 0 to 40°C with no derating. Its minimum efficiency equals 70%; ripple and noise specs at 1% or 100 mV, whichever is greater. Channels 1 and 2 feature overvoltage protection and current-limiting circuitry. $53 (100).

Onan Corp, Power/Electronics Div, 4801 W 81st St, Suite 114, Minneapolis, MN 55437. Phone (612) 921-5600.

Circle No 642

DC/DC CONVERTERS

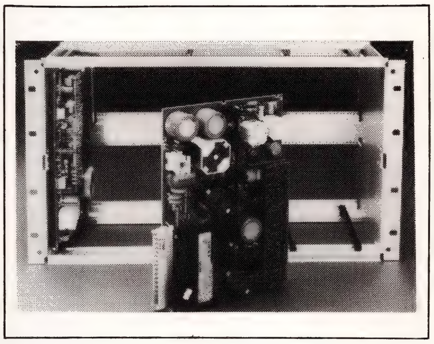
By utilizing variable frequency switching at around 1 MHz, the 2700 Series single-output, isolated dc/dc converters produce typical zero- to full-load output transients of only 0.4V, lasting for 0.65 msec. The zero- to full-load regulation is 0.2% max, and the line regulation over input range is 0.1% max. Converters are available with input voltage ranges of 10 to 20V, 18 to 35V, 35 to 72V, 45 to 90V, 90 to 185V, and 180 to 370V. The nominal output voltage, which is adjustable over the −20 to +15% range, is 2, 5, 12, 15, 24, 28, or 48V.

Standard features include logic-disable inputs, remote sensing, current limiting, and overvoltage protection. The converters are rated for 100W output power, with these exceptions: All the 2V output converters are rated at 30W; the 5V output converters with input voltage ranges of 18 to 35V and above are rated at 75W; and the 10 to 20V input converters other than the 2V output version are rated at 50W. Additional modules that boost the output power are available.

The converters' operating baseplate temperature range is −40 to +100°C; 5%/°C derating is required above 85°C. Their MTBF is 214,000 hours at a baseplate temperature of 80°C. Each unit is housed in a package with a 117×61-mm footprint, and a height (including connection pins) of 20 mm. £130 (100).

Inpower, Ballysimon Rd, Limerick, Ireland. Phone (061) 49677. TLX 70322.

Circle No 643



BACKUP SUPPLY

Incorporating a built-in battery charger and changeover circuitry, the PE5270/33 power supply protects VME Bus system memory during power failures. In addition, it generates the VME Bus ACFAIL and SYSRESET signals. Equipped with an external 5-Ahr/12V battery, the supply can provide 30-minute backup on its main 5V/6A output. In addition to providing this uninterruptible main output, the power supply also offers two isolated 12V/0.2A outputs and one isolated 5V/1A output.

The main output, which features remote sensing, foldback current limiting, and crowbar overvoltage protection, has a regulation of 0.2% max for ±10% line input variation or 20 to 100% load changes. Auxiliary output regulation is less than 5% for combined line and load variations. The PE5270/33 operates from 175 to 264V (or 90 to 140V), 47- to 440-Hz line supplies, with a maximum power rating of 160 VA. Full output power is available at operat-

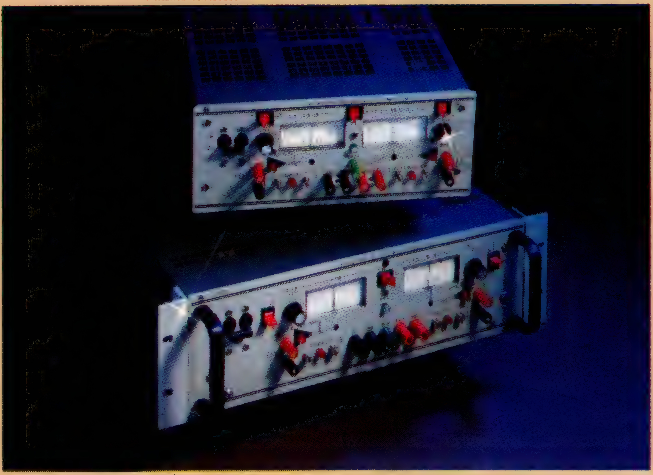
The only power supplies that: source and sink power in both directions; produce stabilized voltage or current, positive or negative, a-c or d-c; and get on the bus without fuss…

Kepco BOP Power Managers™ now have dazzling new speed!

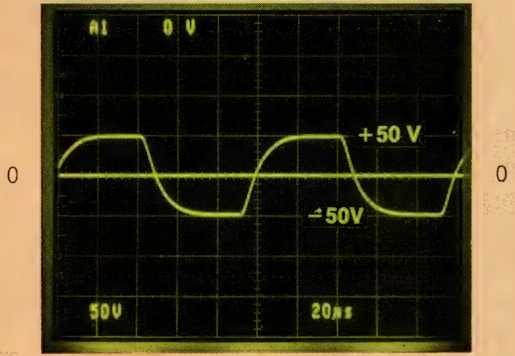
For years, now, people who have wanted a voltage that was equally agile above zero, below zero, and above *and* below zero, have counted on Kepco BOP (bipolar) Power Managers.

There's just nothing else like a BOP. Nothing else that can jump from, say, *plus* 100V to *minus* 100V, or from *minus* 20 Amps to *plus* 20 Amps in microseconds, passing through zero without a glitch. There's also nothing else that can produce rock-steady positive *or* negative voltages in the face of wildly fluctuating current—or vice versa. There's certainly nothing else that can operate not only as a source, but also as a sink, i.e., absorb 100% of its rated voltage or current when its voltage polarity and current direction are out of phase, or when its *load* suddenly turns around and becomes a *source*.

On top of all that, the BOPs have *also* been pretty fast performers. Their bandwidths have ranged from 1.8 to 4.5KHz, their slewing rates from 1 to 2V/µsec. Our model BOP 100-2M, for example, had a bandwidth of 3KHz in both the voltage and the current mode, and could jump from −100V to +100V in 100µsec.



Two groups of BOP Power Managers are available: ¾-rack 100- and 200-Watt models (top), and full-rack 400-Watt models.



Reproduction of a 10KHz square wave by a Kepco bipolar Power Manager Model BOP 50-2M, which actually has a 20KHz bandwidth in the voltage mode.

Well, now Kepco has improved the BOP. That same model can now make that same leap in 20µsec—a fivefold gain, and its bandwidth is 22KHz in the voltage mode, 15KHz in the current mode.

Furthermore Kepco has been able to speed up the BOPs without sacrificing stability—or anything else. They still do all the wonderful things they've always done. They just do it faster.

Incidentally, acquiring dazzling new speed isn't the only thing that's been happening to the BOP series. It's also acquired a new model, the ±200V, ±1 Amp BOP 200-1M. Also, models BOP 500M (±500V/80mA) and BOP 1000M (±1000V/40mA) have had their noise levels significantly improved. Maximum p-p noise on the BOP 500M *was* 500mV, *is now* 100mV. The total range of the BOP 500M is 1000 Volts—from *minus* 500V to *plus* 500V and 100mV noise in a 1000V p-p signal is 100 ppm. That's an 80dB signal-to-noise ratio!

BOP can interface with the IEEE-488 bus using a selection of external controllers, or an optional built-in interface card.

To find out more, call or write Dept. JYF-12.

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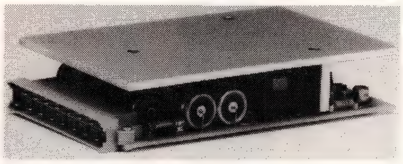

DC/DC CONVERTERS

The SR851, SR8101, and SR8201 single-output, galvanically isolated dc/dc converters have power ratings of 50, 100, and 200W, respectively. They are housed on 100×160-mm single-Eurocard pc boards with respective heights of 20, 30, and 45 mm. Fitted with standard DIN-41612 connectors, these converters are plug-compatible with the company's 3 Series switching regulators and 9 Series dc/dc converters.

The converters are available with nominal output voltages of 5, 12, 15, or 24V. The 5V output is adjustable between 4 and 6V; the 12 and 15V outputs are adjustable between 7 and 16V; and the 24V output is adjustable between 15 and 25V. The available input voltage ranges are 12, 24, 48, and 60V, all ±25%. The converters' load regulation is 1% max for 10 to 90% load changes, and their line regulation is 0.5% max for ±10% input voltage changes. The output ripple and noise is 0.6% p-p max, and spikes to 100 kHz are limited to 1% of output voltage. The converters' inputs are overvoltage protected, and their outputs have external sense connections and short-circuit protection. The units operate over 0 to 70°C, but require 2.5%/°C derating at temperatures above 50°C. SR851, DM 280; SR8101, DM 357; SR8201, DM 466.

Brandner Vertriebs-GmbH, Siemensstrasse 26, 8755 Alzenau, West Germany. Phone (06023) 330105. TLX 4188593.

Circle No 645

SWITCH-MODE SUPPLY

Capable of delivering a total output power of 150W with normal convection cooling, the HSS150 switch-mode power supply provides five outputs that are suitable for powering microcomputer systems. The main output delivers 5V at 12A and the auxiliary outputs provide 12V at 5A, −12V at 2A, −5V at 1A, and 24V at 2A. The main output and the −5V and 24V outputs are fully reg-

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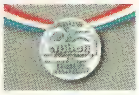

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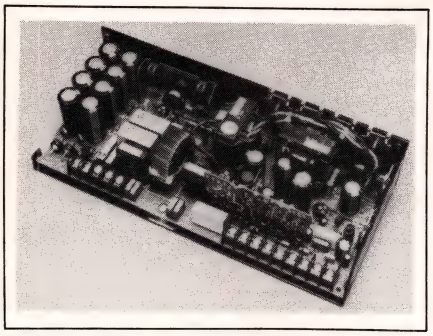

ulated, and the ±12V and 24V outputs can deliver high surge currents without significant voltage drops.

Several standard variants on this 5-output model are also available. Operating efficiency is around 78%, and the supply meets major international safety and RFI-emission standards. The vendor has applied for UL, VDE, and CSA approval, and the unit conforms to IEC and BS safety specifications. It measures 268.5×115×60 mm. Approximately $170.

Weir Electronics Ltd, Durban Road, Bognor Regis, Sussex PO22 9RW, UK. Phone (0243) 865991. TLX 86543.

Circle No 646

Weir Electronics Inc, 418 Third St, Annapolis, MD 21403. Phone (301) 268-0122. TLX 510-600-7370.

Circle No 647

UPS

With a 5-kVA load, the EDP100 uninterruptible power supply provides between 5 and 25 minutes of standby power, depending on the battery configuration supplied. Versions are available for 220/250V, 50-Hz or 110/127V, 60-Hz input and output. The unit provides a single-phase output with a maximum load rating of 5 kVA (4 kW) and a power factor of between 0.6 and 1. You can run the output at 125% of rated load for a period of 10 minutes. The output frequency is internally controlled to ±0.05%, and you can synchronize it over the range of ±2%.

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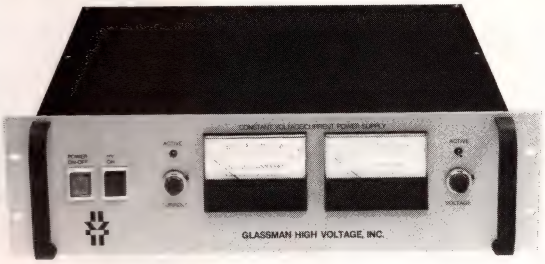

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Circle No 649

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The Model 48S5.1000 dc/dc converter has a 0.375-in. mounted height that allows it to accommodate 0.5-in. board-spacing applications. It operates from a 48V input and provides an output of 5V at 1A. The module carries a 5-year warranty and features a 6-sided metal case that minimizes RFI problems. The key converter specs include 0.05% line/load regulation, 10-mV p-p output noise, 0.3%/1000 hours long-term output stability, and 8-hour min short-circuit protection. Operation spans −25 to +80°C. A mounting kit (MS15) allows you to bring the converter into service in only a few minutes. Model 48S5.1000, $93; MS15, $30.

Calex Manufacturing Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506.

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*PWR5104 is ±12V

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CIRCLE NO 109

safety standards and comply with FCC and VDE conducted-emission standards when configured with optional filtering.

The series' efficiency is 80%. All models provide overload protection by means of foldback current limiting (with automatic recovery), and the outputs are protected against reverse voltages. Overvoltage protection is standard on the main output and optional on other outputs. The supplies have a soft-start feature. Other protection options include line-monitor, logic-inhibit, and thermal-shutdown functions. Output margining is also available. $515 to $875 (OEM qty). Delivery, four to eight weeks ARO.

Deltron Inc, Box 1369, North Wales, PA 19454. Phone (215) 699-9261. TWX 510-661-8061.

Circle No 651

FLEXIBLE SUPPLY

The Case 21 can deliver 600W, offers as many as seven outputs, and is available with either an ac or a dc input. The main output delivers 5V dc at 80A; the secondary outputs are selectable over the 2 to 48V dc range. The supply features output inhibit/enable, input-power-fail and dc-power-good signals, overvoltage and overload protection, remote sensing, and paralleling. The unit meets international safety and EMI/RFI standards, including UL 478, CSA 22.2, IEC 380, and VDE 0806. $0.70 per watt (OEM qty). Delivery, stock to 10 weeks ARO.

Qualidyne Systems Inc, 3055 Del Sol Blvd, San Diego, CA 92154. Phone (800) 455-0425; in CA, (800) 237-6885. TLX 709029.

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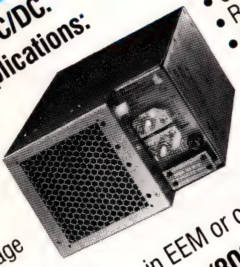
*Number of combinable options may be limited by packaging considerations. Consult factory.



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higher output voltages). Their input voltages range from 10 to 425V, and their output voltages range from 2 to 48V in 50, 75, 100, and 150W power levels. The converters feature logic-disable, current-limiting, and remote-sensing functions, as well as overvoltage protection. Other specs include 0.1% line regulation, 0.2% load regulation, 2% p-p max output noise, and a 100-μsec transient response. The units also incorporate 95°C thermal shutdown. $205. Delivery, six to eight weeks ARO.

Vicor Corp, 23 Frontage Rd, Andover, MA 01810. Phone (617) 470-2900. TWX 910-380-5144.

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The VE100 Series 100W, double-height Eurocard-size switching power supply is plug-in compatible with the VME Bus. The supply is available with either ac or dc inputs. Front-panel LEDs monitor power-on, overvoltage protection, and power-fail-detect operation. The ac power switch is also front-panel mounted for easy access. The outputs are 5V dc at 1.8 to 9A and ±12V dc at 0.05 to 2A. All outputs have a 10% adjustment range. The series includes an onboard DIN connector and features wide-input switcher technology—automatic 90 to 250V ac or 100 to 350V dc (no taps, straps, or jumpers necessary). $184 (100). Delivery, six weeks ARO.

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Endicott Research Group Inc, Box 269, Endicott, NY 13760. Phone (607) 754-9187.

Circle No 655

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Nine models of this 3-output, 25W dc/dc converter series accept 9 to 18V, 18 to 36V, or 36 to 72V dc. The available outputs are 5 and ±12V, 5 and ±15V, or 12 and ±5V dc. All Series 730 models feature line regulation of ±0.5% and load regulation of ±1%. Each has a TTL-compatible input for remote on/off control, as well as an internal filter to minimize reflected input ripple current. The converters' efficiency is 82%. They measure 2.56×4.56×0.83 in. and come in a copper case that's shielded against EMI and RFI. $179.

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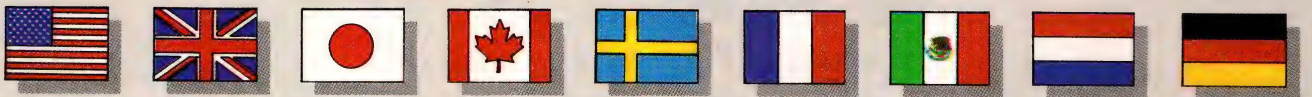

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* Electronic Buyers' News, Annual Top 100 Component Suppliers Survey... 1984, 1985, 1986.

CIRCLE NO 97

DESIGN IDEAS

EDITED BY TARLTON FLEMING

MOSFET circuit debounces power relay

Carlo Venditti
The Charles Stark Draper Laboratory Inc,
Cambridge, MA

You can eliminate turn-on bounce in an electromechanical relay by connecting an n-channel power MOSFET across the relay terminals **(Fig 1)**. The MOSFET's high peak-current rating (108A for the unit shown) allows it to carry the load current when the relay contacts bounce open. As an additional benefit, the low on-resistance of the relay carries most of the current, eliminating the need for a heat sink on the MOSFET.

When the relay is off (S_1 open), a trickle of current through the relay coil biases Q_3 on, which in turn holds Q_2, Q_1, and MOSFET Q_4 off. Closing S_1 quickly toggles the state of all four transistors, turning on Q_4 before the first contact bounce occurs. The 15V zener diode (D_1) protects the MOSFET by clamping V_{GS} at a level below its maximum rating.

Fig 2a shows the sharing of the load current between the MOSFET and the relay for a resistive load Z_L of 2Ω. A second scope photo shows the total load current through Z_L **(Fig 2b)** for the same operating conditions. Note the absence of discontinuities in this waveform. **EDN**

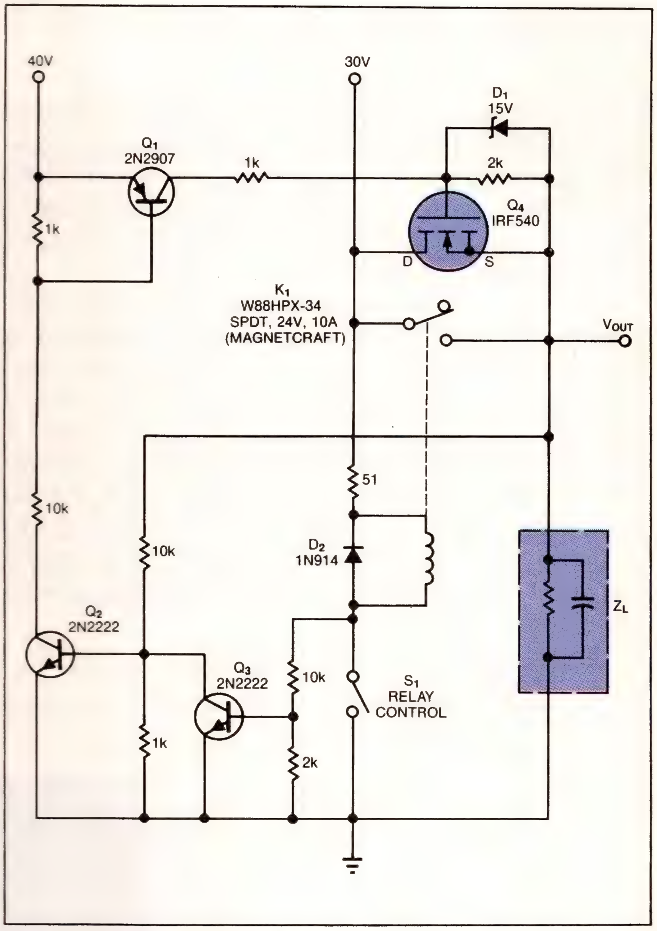
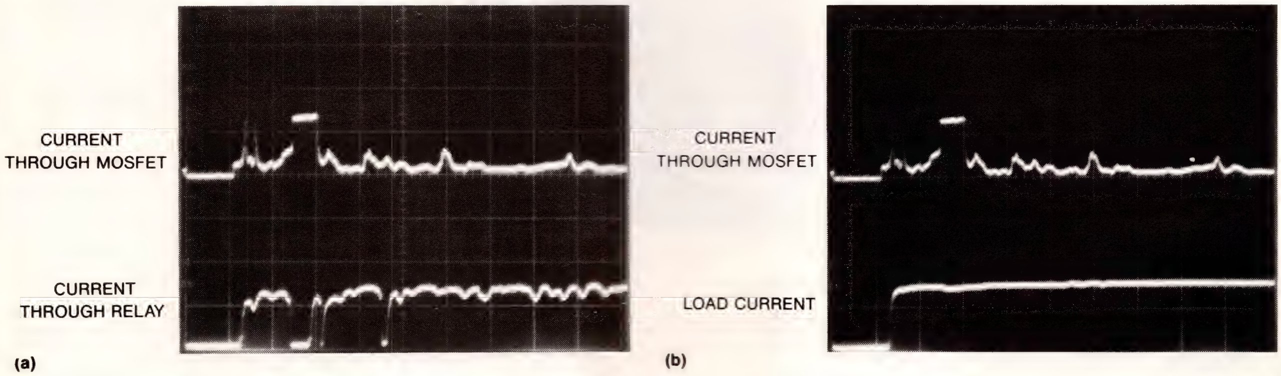


Fig 1—This circuit operates a power MOSFET (Q_4) in parallel with the terminals of an electromechanical relay. Q_4 debounces the relay by conducting load current when the relay terminals bounce open.

To Vote For This Design, Circle No 750



NOTE: FOR ALL TRACES, THE VERTICAL SCALE IS 10A/DIV AND THE HORIZONTAL IS 0.2 mSEC/DIV.

*Fig 2—These scope photos show the operation of Fig 1's circuit with a 2Ω load (Z_L). In **a**, Q_4 and the relay conduct load current alternately as the relay contacts bounce. In **b**, the lower trace shows that the resulting current through Z_L is free of discontinuities.*

Circuit monitors bipolar battery supplies

Alan Rich
Linear Technology, Haverhill, MA

A battery's output voltage enables a monitor circuit to detect depletion of the battery's stored charge, especially when the battery is supplying load current. Using a comparator and a voltage reference, you can monitor a single battery, but a bipolar battery supply requires a more elaborate circuit.

Fig 1's circuit, for example, is suitable for a ±6V system and draws less than 500 µA. Based on a dual-comparator CMOS IC, the circuit provides separate out-of-limit signals for the two 6V batteries; a third OR output warns when either battery is low.

Resistors R_1 and R_2 set the positive battery's comparator-trip voltage at 5.5V. Similarly, R_3 and R_4 set the negative battery's trip voltage at −5.5V. R_5 and capacitor C_1 set the time interval between battery checks; component values as shown produce a check approximately every 10 seconds.

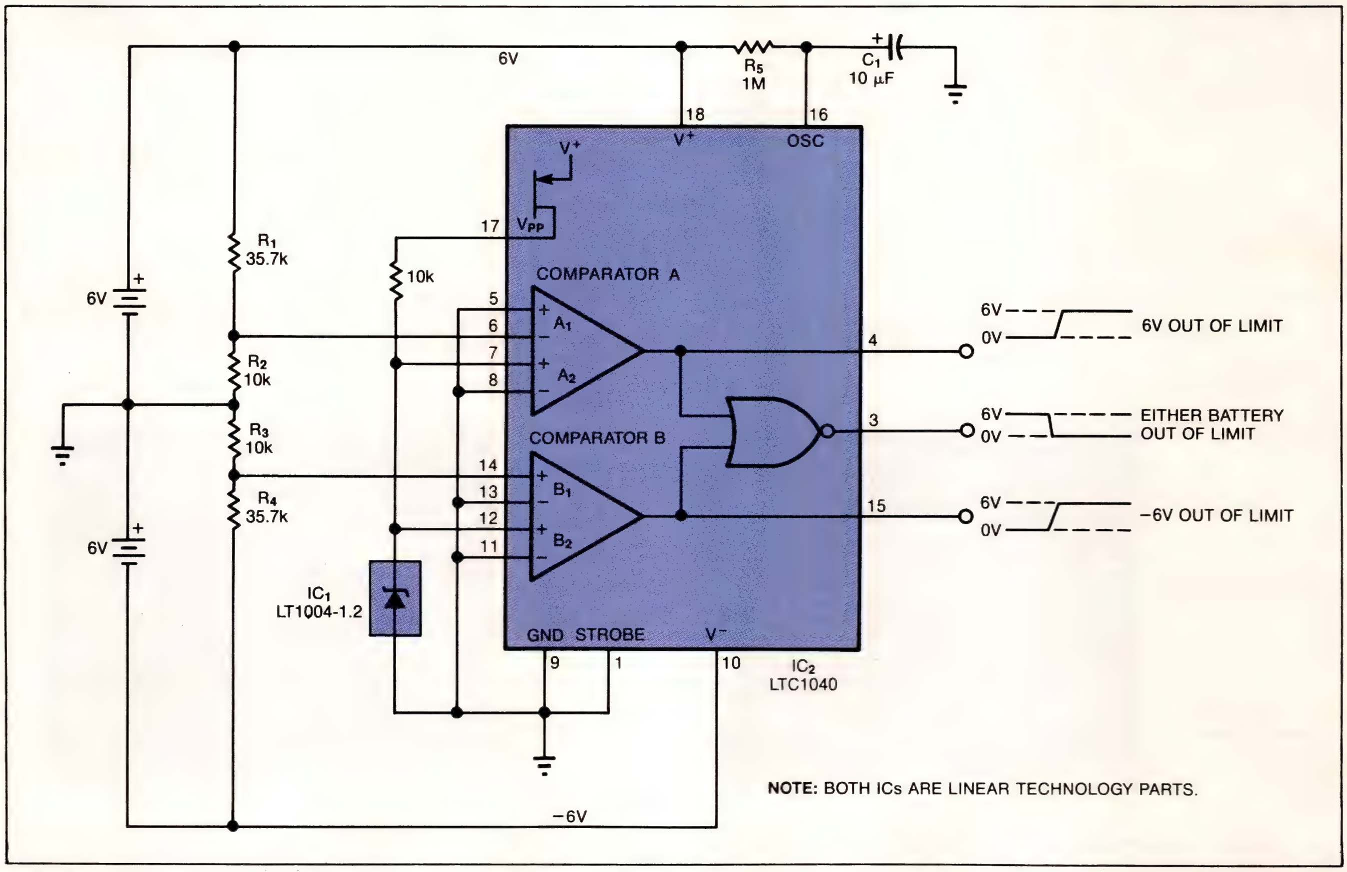
IC_2 activates its internal monitoring circuitry for only 80 µsec or so. In addition, the chip provides a pulsed-power output (V_{PP}) that conserves power by turning on only during the 80-µsec battery check. This output powers IC_1, which provides each comparator with a reference voltage of 1.2V.

Further, each comparator has dual-differential inputs; the output is high when the sum of the comparator's inputs is positive and low when the sum is negative. Comparator A's output is a logic one when

$$(A_1^+ - A_1^-)+(A_2^+ - A_2^-)>0,$$

or a logic zero when the expression is <0.

The similar but more sophisticated monitor circuit of **Fig 2** uses IC_2's V_{PP} output to power IC_1 and to draw a brief load current from the batteries as well. This circuit uses a 10-mA load and achieves a more effective test than that of **Fig 1** because a nearly discharged battery may have a normal output voltage with a light



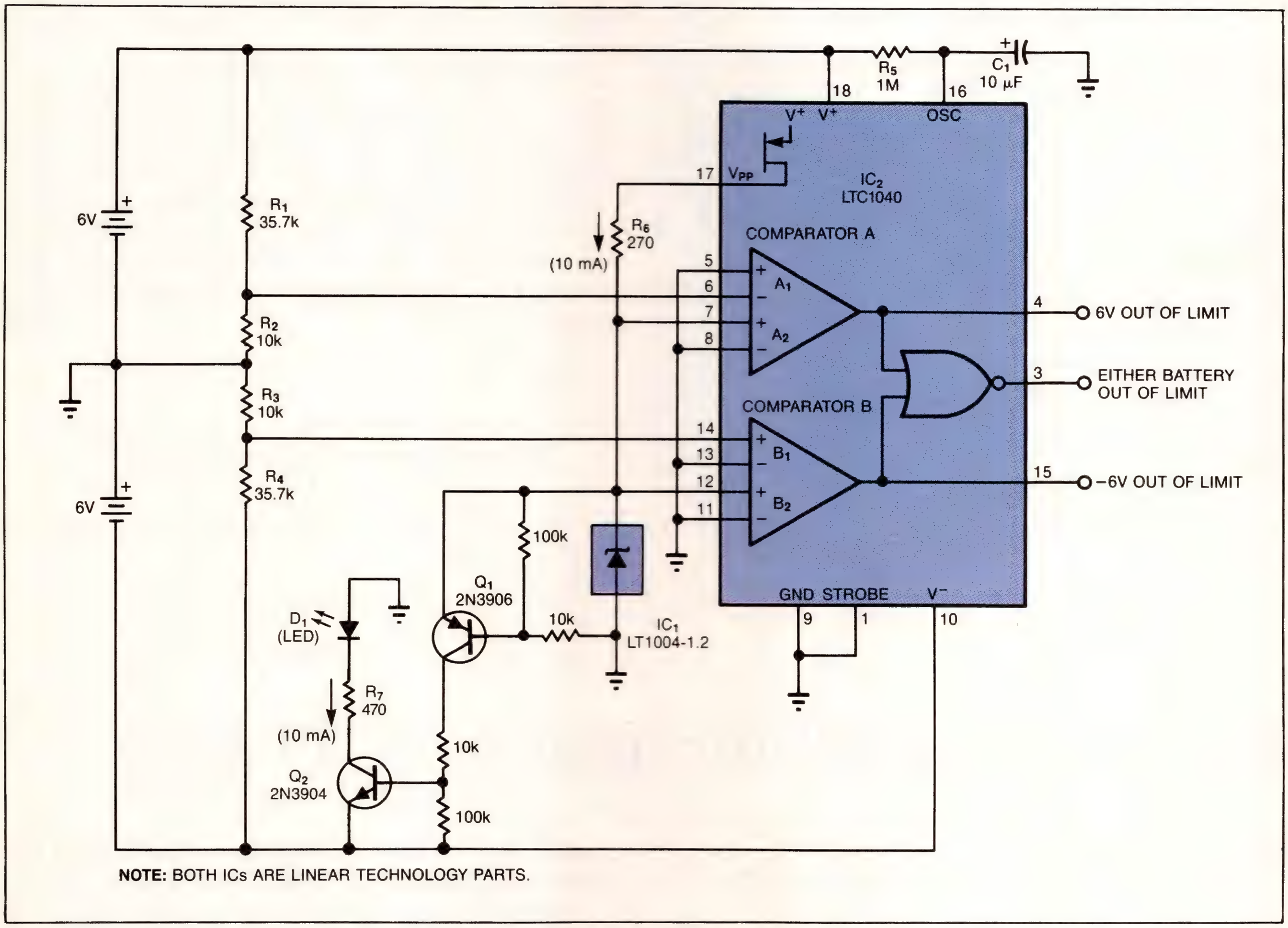
NOTE: BOTH ICs ARE LINEAR TECHNOLOGY PARTS.

***Fig 1—This monitor circuit performs** an 80-µsec check of both 6V-battery outputs every 10 sec and asserts an alarm signal if either output drops below 5.5V.*

load but will have a near-zero output at a higher load current.

The 10-mA load current from the positive battery flows through R_6 and IC_1 during the test period. Similarly, R_7 sets a 10-mA load current for the negative battery. This current flows through R_7, LED D_1 (optional—it indicates the battery test), and transistor Q_2. Note that you can place either of the **Fig 1** or **Fig 2** circuits under µP control by using IC_2's strobe input (pin 1) instead of the internal oscillator. **EDN**

To Vote For This Design, Circle No 746



NOTE: BOTH ICs ARE LINEAR TECHNOLOGY PARTS.

Fig 2—Similar to Fig 1, this monitor circuit *is more effective at battery testing because it draws a 10-mA load current from each battery only during the 80-µsec test period.*

Software enhances µP watchdog circuit

James W Morrow
Linear Corp, Carlsbad, CA

By adding a software routine to support your µP system's watchdog reset circuit, you can prevent erratic or runaway operation by the µP. First, prefill all program-memory locations with a valid jump instruction; then, load your program. Consequently, all program locations not used by the program will contain the jump instruction instead of the usual invalid-op-code or NOP instructions. If for some reason the program addresses any of these invalid locations, it will jump to a specific location that tells it to loop back on itself and then wait for an external signal to reset the processor.

Table 1 shows the memory map that implements this idea for 8048 Series processors; you can use a similar approach for other processor types. In the case of the 8048, fill the memory with op code \$04, which tells the processor to jump to memory page 0. The processor will fetch the next byte as well to make up the 2-byte instruction, and this instruction (\$04,\$04) directs the program to page 0, location \$04. Storing the value \$04 at this location and at location \$05 will create a loop that will keep the processor occupied until it receives a reset signal from the external hardware. (The program can go directly to a software-reset routine, but note that some software reset signals don't bring all the registers and memory back to the proper state).

TABLE 1—MEMORY MAP

MEMORY LOCATION	HEX CONTENTS	DESCRIPTION
03	XX	TIMER INTERRUPT VECTOR (JUMP)
04	04	SECOND PART OF ABOVE, AND WATCHDOG
05	04	SECOND PART OF WATCHDOG VECTOR
—	—	—
—	—	—
PAGE 1		
00	04	WATCHDOG FILL
01	04	WATCHDOG FILL
02	04	WATCHDOG FILL
03	04	WATCHDOG FILL
04	XX	BEGIN TIMER
05	XX	INTERRUPT
06	XX	ROUTINE

A restriction applies when you use this memory-map technique with the 8048. Memory location \$03 contains the timer-interrupt vector; usually you place a jump statement at this location, which directs the program to a timer-interrupt routine. Because you've planted \$04 in the second byte of this jump statement (the first byte is in location \$03), however, your timer-interrupt routine must begin at location \$04, regardless of page number. **EDN**

To Vote For This Design, Circle No 748

Square-wave oscillator spans dc to 20 MHz

Michael Jachowski
Precision Monolithics Inc, Santa Clara, CA

The digitally controlled oscillator of **Fig 1** is useful as a clock source for switched-capacitor filters, and it costs less than \$1 (OEM qty). During operation, the voltage at node A oscillates between the hysteresis thresholds at the input of IC_{2A}, a Schmitt-trigger inverter. The D/A converter, IC_1, sets the oscillation frequency by controlling the current into pin 4 (I_O), which sets the charge rate for capacitor C_1.

To understand how the circuit oscillates, first assume that C_1 is discharged (the node A voltage is 5V). Node B is at 0V, so diode D_1 is reverse biased. The current into pin 4 of IC_1 determines the linear charge rate of C_1; this current ranges from 4 μA to 4 mA, depending on the D/A converter's input code D and reference current I_{REF}. C_1 charges until node A's voltage ramps below the lower switching threshold (V_{TL}) of IC_{2A}.

The output of inverter IC_{2A} then switches high, although it clamps briefly at the voltage level of node A plus the diode's forward-voltage drop. The inverter can deliver more than 50 mA in this state, overdriving the D/A converter's output current and rapidly discharging C_1. When node A rises to the inverter's upper threshold V_{TH}, node B returns to 0V and the cycle repeats.

Inverter IC_{2B} buffers the capacitor-discharge current and provides a negative-strobe output; IC_{2C} provides a positive strobe. Flip-flop IC_3 provides a square-wave output at one-half the strobe frequency (**Fig 2**). The strobe period T equals T_1+T_2 (within the converter's 8-bit accuracy) for frequencies below 200 kHz and for values of C_1 greater than 1000 pF:

$$T \approx \frac{C_1(V_{TH}-V_{TL})}{I_{REF}D} + 60C_1\ln\left(\frac{5-V_{TL}}{5-V_{TH}}\right),$$

where D=(digital input)/256.

For C_1 values below 1000 pF, you must account for stray capacitance. The following will add stray capacitance directly to C_1: converter output, 12 pF; inverter input, 5 to 10 pF; diode, 2 pF. An IC socket will

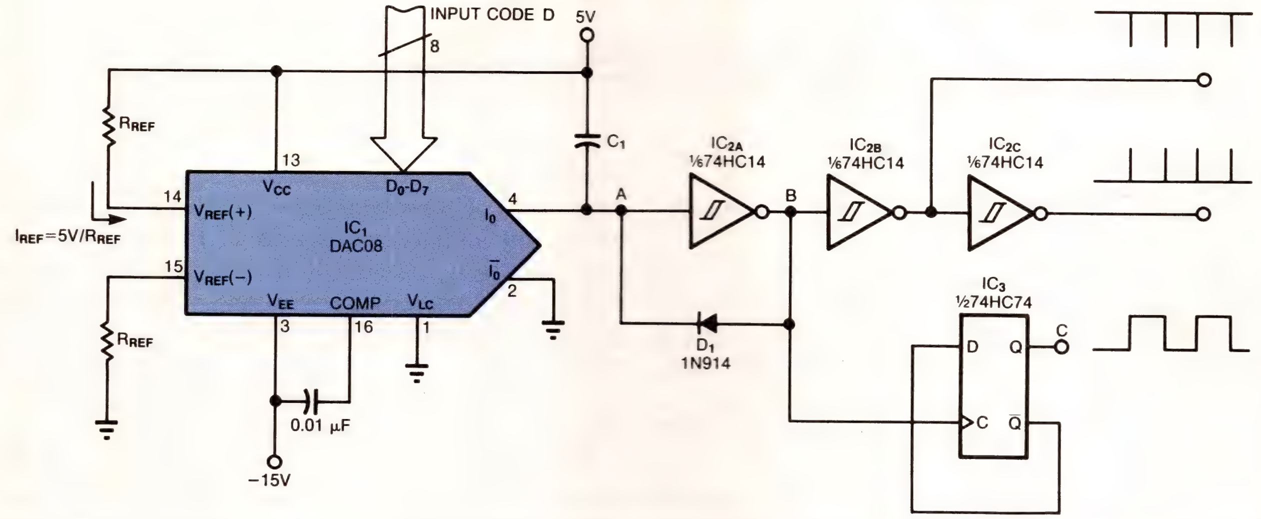


*Fig 1—**This digitally controlled clock oscillator** provides linear control below approximately 200 kHz and has a maximum frequency higher than 20 MHz.*

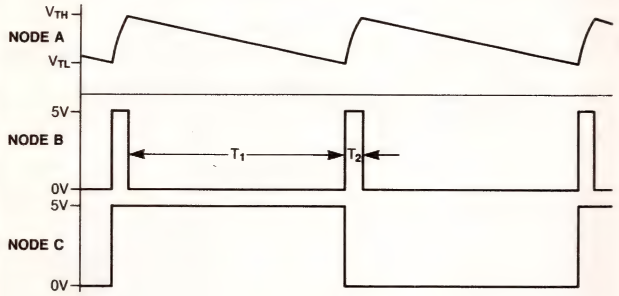


*Fig 2—**These idealized waveforms from Fig 1** illustrate the oscillator's operation for frequencies of 200 kHz and below.*

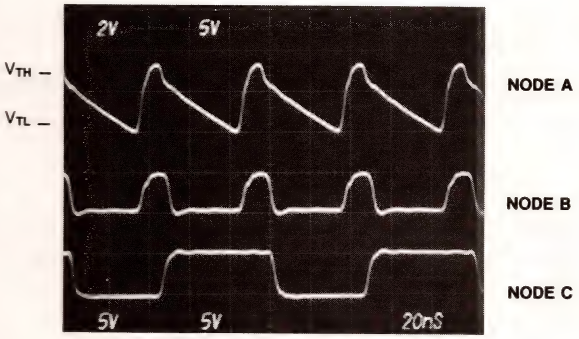
contribute additional capacitance. For strobe frequencies greater than 200 kHz, you must also include the effects of the inverter output's rise and fall times and its propagation delay T_{PD}:

$$T\approx(C_1+C_{DAC}+C_{2A}+C_D)\left[\frac{V_{TH}-V_{TL}}{I_{REF}D}+60\ln\left(\frac{5-V_{TL}}{5-V_{TH}}\right)\right]+T_{RISE}+T_{FALL}+T_{PD},$$

where C_{DAC} is the converter's output capacitance, C_{2A} is IC_{2A}'s input capacitance, and C_D is the diode's capacitance.

Fig 3 shows the oscillator operating at a strobe frequency of 20 MHz. Capacitance at node A is 30 pF (including 10 pF from the oscilloscope probe). Notice that the fast-moving node A waveform overshoots both switching thresholds, producing an amplitude of 3.5V. Frequency vs input D becomes nonlinear at higher frequencies because of propagation delays, rise times, and fall times in the inverter. At 20 MHz, for example, the converter controls less than half of the waveform period at node A.

Although the oscillator is capable of high speed, its operation is more stable below 200 kHz. You can set the converter's I_{REF} as low as 100 µA and set C_1 as high as you like—resulting in an operating frequency with no significant lower limit. For higher accuracy and greater dynamic range, you can replace the DAC-08 with a 10- or 12-bit D/A converter. **EDN**



TRACE	VERTICAL	HORIZONTAL
NODE A	2V/DIV	20 nSEC/DIV
NODE B	5V/DIV	20 nSEC/DIV
NODE C	5V/DIV	20 nSEC/DIV

*Fig 3—**These waveforms are of Fig 1's circuit** operating at 20 MHz. The strobe pulse width (node B) equals the sum of the rise time, fall time, and propagation delay for inverter IC_{2A}.*

To Vote For This Design, Circle No 747

Line tap aids software debugging

Peter J Ashenden
University of Adelaide, Adelaide, SA, Australia

A simple circuit can aid in the development of a μP system by spying on the protocol exchange between a host-resident debugger program and a target-resident monitor program **(Fig 1)**. Although the circuit was built for an NS32000 system, you may use this approach wherever two or more systems communicate over RS-232C lines using a half-duplex protocol.

In developing a μP system, you edit and compile source code on the host, then invoke the debugger to load the resulting object code into the target system. A monitor program (running on the target system) accepts the loaded code and oversees execution. The debugger can instruct the monitor to examine the contents of memory locations, to set breakpoints, and to perform other tasks.

The difficulty lies in getting the monitor to operate properly on the bare target system. An in-circuit emulator (ICE) is a vital but expensive tool for this job. Even using an ICE, however, you'll find it difficult to be sure that the monitor and host debugger are interacting as they should. The spy circuit helps you in this regard by observing the exchange between the monitor and debugger programs and displaying the combined dialog on a terminal. Character collisions don't occur because the two programs take turns communicating.

IC_1 is a dual RS-232C transceiver that uses internal charge pumps to derive the RS-232C supply voltages (±12V) from a 5V source. The chip's two receivers accept the monitor's and the debugger's dialog. IC_2 then combines these signals and feeds them to the display terminal via one of IC_1's two data transmitters. **EDN**

To Vote For This Design, Circle No 749

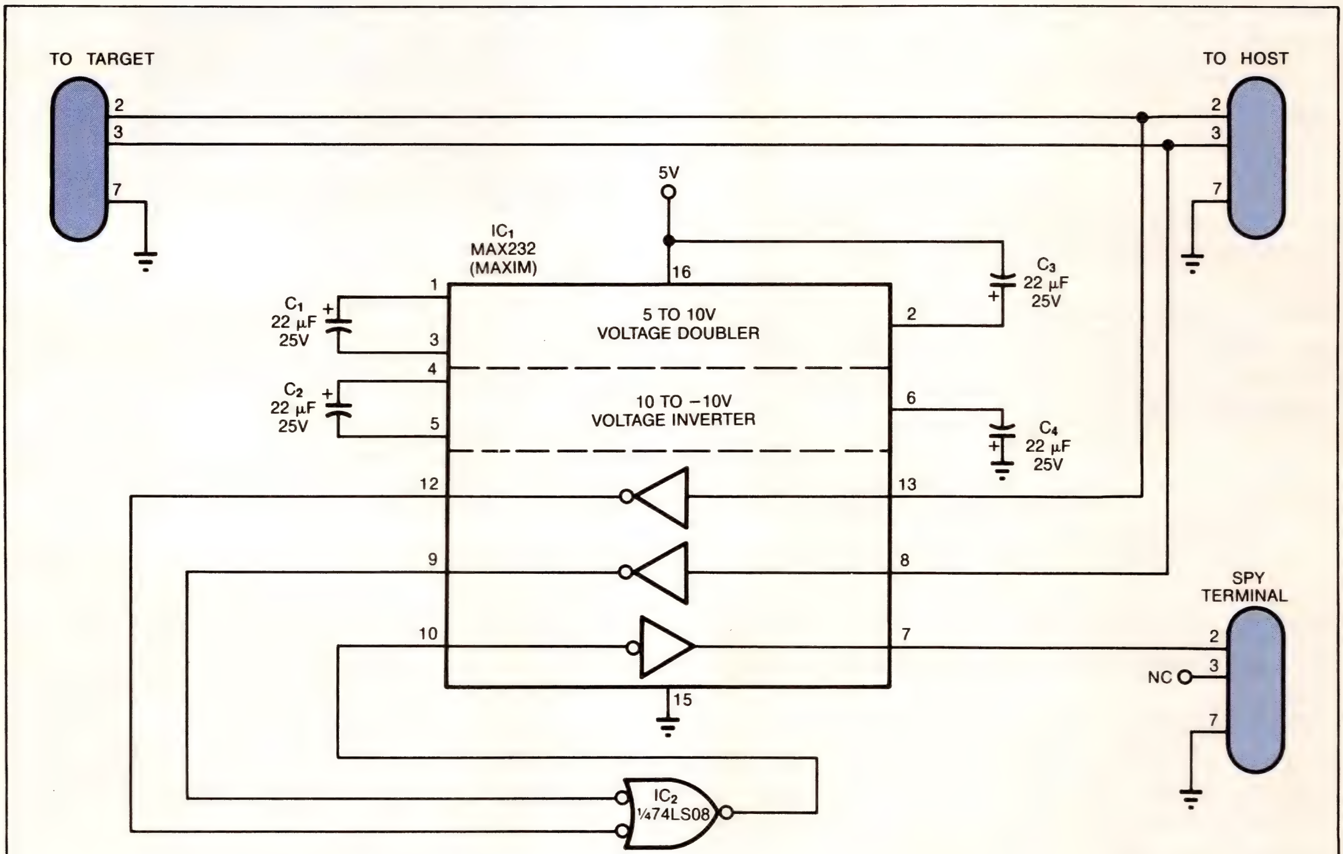


Fig 1—This spy circuit lets you observe the exchange *of information between a host-resident debugger and a target-resident monitor program.*

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ISSUE WINNER

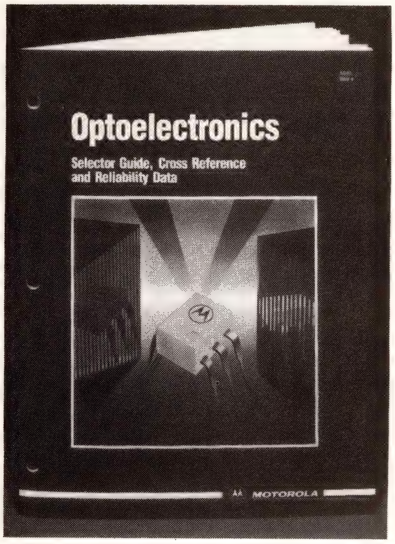
The winning Design Idea for the April 15, 1987, issue is entitled "IC replaces mechanical-interlock switches," submitted by Charles E Murphy of Elcotel Inc (Sarasota, FL).

All about attenuators

This 2-pg data sheet describes the company's In-A-Cable subminiature attenuators, which come in semirigid cable assemblies. The bulletin presents three tables. One table lists general technical data: SWR, power-dissipation ratings, temperature and power sensitivity, peak voltage characteristics, dimensions, and weight. Another lists materials and specs for all attenuator parts. The third table gives mechanical and environmental characteristics, including pressure, corrosion resistance, shock, moisture, and vibration. In addition, graphs plot performance curves for SWR vs frequency and for power derating under various temperature conditions.

Micro-Coax Components Inc, Collegeville, PA 19426.

Circle No 661



Guide lists optoelectronic devices

The 31-pg *Optoelectronics Selector Guide* (Catalog SG87R4/D) includes more than 20 new-product families. It's divided into sections on emitters/detectors, optoisolators, optointerrupters, and fiber-optic components. It also provides an industry cross-reference and a section that presents reliability data on the company's Opto 400 and optoisolator dome packages.

Motorola Inc, Literature Distribution Center, Box 20924, Phoenix, AZ 85063.

Circle No 663

Handbook is source of data on signal filtering

The Application of Filters to Analog & Digital Signal Processing is a design handbook for both inexperienced and seasoned engineers. It's a useful primer for those unfamiliar with the concepts and applications of filters in signal-processing systems, and it's a solution-oriented technical reference for signal-processing problems. The book begins with fundamental ideas and gradually introduces more advanced concepts. Topics include analog signals and their spectra; noise; signal filtering at the input and at the output; sampling signals; types and characteristics of filters; and ATE system applications. Illustrations complement the text.

Wavetek San Diego Inc, Box 85265, San Diego, CA 92138.

Circle No 662

Booklet describes properties of boron nitride

This 12-pg booklet details the properties, applications, and benefits of Combat boron nitride, a material with high thermal conductivity that can withstand temperatures to 2800°C. The catalog, which is suitable for loose-leaf filing, discusses solids, powders, and coatings and provides tables for each type.

Standard Oil Engineered Materials Co, Electronic Ceramics Div, Box 664, Niagara Falls, NY 14302.

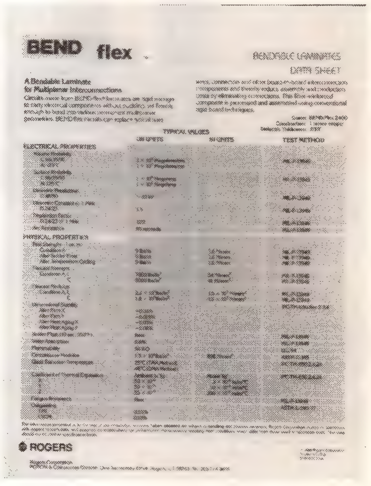
Circle No 666

Two books reference power MOSFETs

These two data books offer information on the manufacturer's power products and COOLFET MOSFETs. The 250-pg power-products compendium provides data sheets on power MOSFETs, ultrafast-recovery rectifiers, and MOSFET and rectifier dice. It also covers applications data for power supplies and motor controls, and it includes a selection guide and a cross-reference. The 96-pg COOLFET booklet contains selection guides and spec sheets for each of the 16 n-channel power MOSFETs.

Fairchild Semiconductor Corp, c/o Analog Div, 313 Fairchild Dr, Mountain View, CA 94039.

Circle No 664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DATA SHEET

A Bendable Laminate for Multiplanar Interconnections

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ROGERS

Data sheet on copper-clad epoxy

This 1-pg data sheet describes Bend/flex—a bendable laminate designed for multiplanar circuitry—which is an alternative to nondynamic flexible circuits and rigid pc boards connected with electronic conductors. The data sheet lists the copper-clad epoxy material's electrical properties, including volume and surface resistivity, dielectric constant, dissipation factor, and arc resistance. It provides information on physical properties such as peel strength, flexural strength, water absorption, and glass transition temperature.

Rogers Corp, Poron & Composites Div, 1 Technology Dr, Rogers, CT 06263.

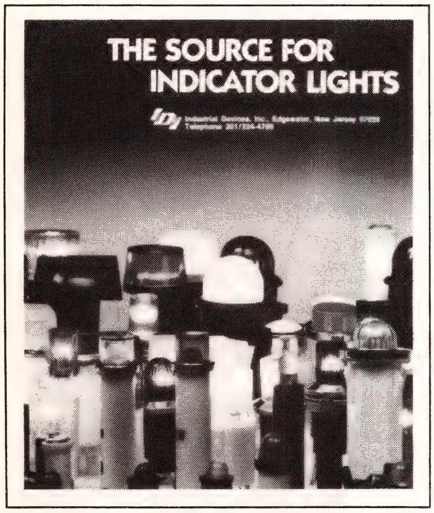
Circle No 667

Catalog features control instrumentation, components

The *Summary Catalog*, a 24-pg reference for the manufacturer's electromechanical control instruments, covers such products as free and rate gyroscopes, vertical indicators, potentiometers, accelerometers, pendulums, and solid-state rate sensors. In addition, it presents information on dynamic test systems, a 4-gimbal platform, stabilization systems, and magnetometers. Along with short product descriptions, the catalog contains specifications and dimensional drawings.

Humphrey Inc, 9212 Balboa Ave, San Diego, CA 92123.

Circle No 665



Full-line catalog covers indicator lights

This 208-pg catalog is an extensive source book and user's guide for selecting indicator lights. It includes information on LEDs, incandescent and neon indicators, and sockets and lenses in a broad range of sizes, shapes, and colors for a wide variety of applications. Full-size photos, dimensional drawings, mounting information, descriptions of features, and complete electrical and mechanical specifications and ratings are included for each indicator. A standard-product-variations section allows an engineer to design indicators tailored to specific application needs by using standard housings, bezels, lenses, lamps, mountings, and terminations. The book also includes a 24-pg cross-reference index to 12 other manufacturers' indicator lights.

Industrial Devices Inc, 7 Hudson Ave, Edgewater, NJ 07020.

Circle No 673

Specs for oscillators

This 12-pg catalog updates the specifications for the vendor's surface-mount crystals and temperature-compensated and voltage-controlled oscillators. Catalog C/D5 also contains an ordering-guidelines section to help in the selection of crystal and oscillator components, and it lists local factory representatives.

Bliley Electric Co, Box 3428, Erie, PA 16508.

Circle No 668

Catalog lists optical and industrial products

This 4-color, 148-pg catalog features more than 5000 of the vendor's optical and industrial products. It includes a comprehensive section addressing precision lenses, optics, mirrors, prisms, fiber optics, optical instruments, and lasers, as well as a section on magnifiers, magnets, microscopes, telescopes, and accessories.

Edmund Scientific Co, Dept 5554, Edscorp Bldg, Barrington, NJ 08007.

Circle No 670

Piezofilm kits, components described in bulletin

This 8-pg bulletin features descriptions of piezofilm kits, sheet film, metallization patterns, and sensor components. It tabulates properties of piezofilm and provides graphs of the film's thermal and frequency responses, circuit schematics, and infrared absorption spectra. The design kits described include a kit for demonstrating basic piezo/pyroelectric effects, vibration sensor kits, and a switch kit—each of which contains sample components and documentation. The bulletin also discusses silver-ink and sputtered nickel/aluminum patterns.

Pennwalt Corp, Box 799, Valley Forge, PA 19482.

Circle No 672

Catalog provides overview of components

This 16-pg short form catalog (13C333) offers an overview of the company's major product lines. It discusses electromechanical relays, contactors, time-delay relays, solid-state relays, input/output modules, and magnetic and thermal circuit breakers. The catalog offers photographs and listings of specifications for each component line.

Potter & Brumfield Inc, 200 S Richland Creek Dr, Princeton, IN 47671.

Circle No 671

Catalog delineates semiconductor devices

The 200-pg *Semiconductors Catalog 1987* provides general information and selector guides for the company's range of discrete semiconductor devices. The selector guides contain enough device-parameter information for you to choose devices for particular applications. Devices listed in the catalog include diodes, rectifiers, bipolar transistors, FETs, thyristors, triacs, RF modules, optoelectronic components, liquid-crystal displays, sensors, surface-mounting components, and hybrid devices. Additional information is provided on package outlines.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands.

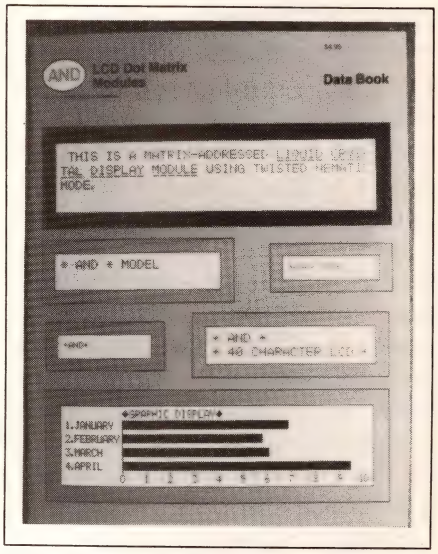
Circle No 677

Book lists LCD modules

The 1987 edition of this 64-pg data book contains the latest information on the company's line of LCD dot-matrix character display and graphics display modules. The book offers the reader design information and complete product specifications for character-display interfacing, and it discusses many new models of both intelligent character and intelligent graphics display modules.

AND, 770 Airport Blvd, Burlingame, CA 94010.

Circle No 674



Guide reviews use of metal-film resistors

This designer's guide provides data on the company's CPF Series of flame-proof metal-film resistors, and it cross-refers them with other types of metal-film and metal-oxide resistors. In addition to including specifications for the devices, the guide contrasts their flame-proof coating with the flame-retardant coatings on many power resistors.

Dale Electronics Inc, 2064 12th Ave, Columbus, NE 68601.

Circle No 669

Brochure covers power modules

This brochure discusses the company's FETMOD and MOSBIP isolated power modules. The booklet, a compendium of the most relevant technical information about the two products, includes dimensional drawings, circuit diagrams, and easy-to-read charts that delineate the products' maximum ratings and electrical characteristics.

Powerex Inc, Literature Distribution Center, 318 First St, Liverpool, NY 13088.

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CIRCLE NO 45

MOSFET handbook

Containing more than 340 pages, the *MOSFET Technical Handbook* provides data-sheet information on the company's range of n- and p-channel enhancement-mode MOSFET devices. All the devices detailed use vertical DMOS structures and are available in E-line (TO-92 style), SOT-23, TO-39, and TO-220 packages. The handbook includes data on 20 new surface-mounting MOSFETs, and it lists types suitable for both switching and linear applications.

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham, Lancashire OL9 8NP, UK.

Circle No 679

Updated catalog describes ferrite materials and cores

This 35-pg catalog describes the company's line of ferrite materials, cores, and accessories. It provides a general survey of products and simplifies the selection of materials, cores, and accessories. Major technical characteristics and ordering codes are included. The specifications listed are sufficient enough to allow the designer to select the correct core material and type for a given application. For those engaged in switching-power-supply design, the catalog includes information on core materials that are optimized for low power loss and for operation to 300 kHz.

Siemens Components Inc, Special Products Div, 186 Wood Avenue S, Iselin, NJ 08830.

Circle No 675

Brochure helps in transistor mounting

TP227-Long-life mounting for lf power transistors is an 18-pg technical publication that provides insights into the possible causes and prevention of mounting problems for low-frequency power transistors. It outlines correct mounting procedures for standard TO-3-, TO-126-, TO-220-, SOT-82-, SOT-93-, and SOT-186-packaged low-frequency transistors, describing in detail the factors involved in obtaining optimal heat sinking. The definitions of thermal-resistance parameters are explained. It also shows how to prevent electrical breakdown of the insulation when you need to insulate the transistor from the heat sink. The publication covers both spring-clip and screw mounting methods.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands.

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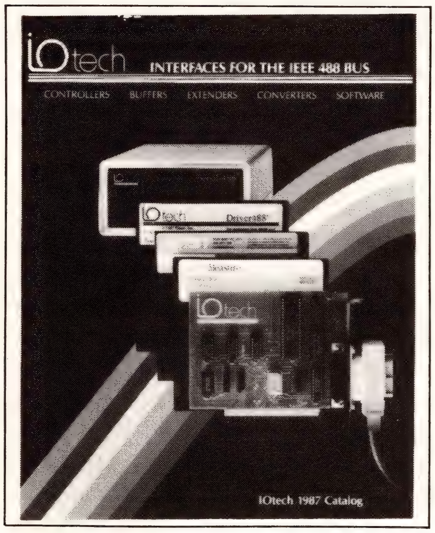
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Driver488
IOtech 1987 Catalog

Catalog describes IEEE-488 interfaces

The 1987 catalog of *Interfaces for the IEEE-488 Bus* includes a listing of seven PC products, which provide an interface among IEEE-488 instruments, plotters, printers, and IBM PCs or compatible computers. The publication describes how the manufacturer's Personal488 hardware/software combination makes programming IEEE instruments from the IBM PC easier.

IOtech Inc, 23400 Aurora Rd, Cleveland, OH 44146.

Circle No 559

Status and future trends of optical storage

The market research report, *The Impact of Optical Technology on Paper, Microform and Magnetic Disk and Tape Storage* is the result of a study on the current status and future trends in optical storage. It describes what the market for optical storage will be over the next five years, gives insight into the impact IBM will have on the adoption of optical-storage technology in the office, and explains the software issues that have a large impact on the acceptance and the speed of implementation of optical storage in office applications. $1250.

Electronic Trend Publications, 12930 Saratoga Ave, Suite D1, Saratoga, CA 95070.

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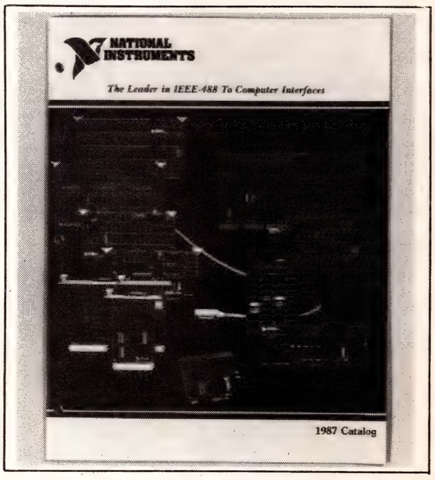
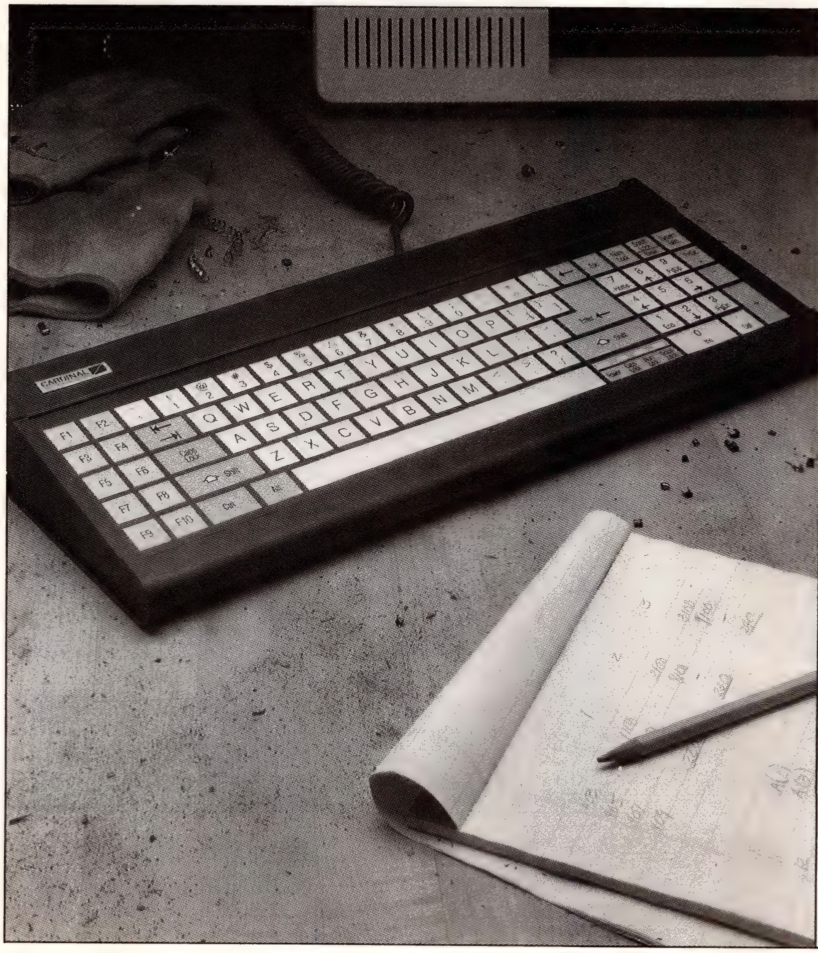


Interface products for the IEEE-488 bus cataloged

This 1987 catalog covers the vendor's IEEE-488-bus interface prod-



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CIRCLE NO 48

ucts, which are available for IBM PCs, PC/XTs, PC/ATs, RT PCs, and compatibles; for Apple, AT&T, Tandy, Texas Instruments, Apollo, Sun, Compaq, Motorola, and NCR machines; and for the Q Bus, Unibus, VME Bus, Multibus, S-100 Bus, STD Bus, and SBX Bus. The 24-pg document includes such offerings as a family of intelligent interfaces that support AT&T 3B2 computers and TI Explorer workstations. It also contains information about bus extenders, converters, and testers, as well as data on training for the IEEE-488 bus.

National Instruments, 12109 Technology Blvd, Austin, TX 78727.

Circle No 561

Guide to add-in memory

This 80-pg booklet is a designer's guide to add-in memory. It contains data on 20 system buses, details of memory design for high-performance buses, elements to consider when configuring a system and selecting memory products, analyses of economic factors, and an industry overview. The final chapter of the guide describes the manufacturer's line of DEC-compatible memories and memories for high-performance microcomputers. A table of specifications completes the treatment of the subject.

Clearpoint Inc, 99 South St, Hopkinton, MA 01748.

Circle No 560

Data sheet details fault-tolerant computers

This preliminary data sheet covers 200/400XR Series fault-tolerant computers and how they bring fault tolerance into the supermicrocomputer and minicomputer price range. Along with block diagrams and a black-and-white photo, the 6-pg publication gives an overview of system operation, lists optional communications interfaces, describes the different configurations,

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CIRCLE NO 50

and devotes an entire page to complete specifications.

Parallel Computers Inc, 3004 Mission St, Santa Cruz, CA 95060.

Circle No 563

Data book addresses VME Bus products

This 380-pg data book is divided into 12 chapters containing more than 75 photographs and more than 100 block diagrams. It features descriptions of CPU boards, memory boards, controllers, I/O boards, software, development systems, and accessories. Bulleted lists of significant features accompany each product description. Application notes and a where-to-buy list complete the treatment. The book is free if requested on letterhead.

Force Computers Inc, 727 University Ave, Los Gatos, CA 95030.

INQUIRE DIRECT

SCSI reference guide

A comprehensive reference on SCSI, *The SCSI Source Guide*, provides information for engineers, product planners, and marketing personnel who need to know what SCSI products are available, who manufactures them, what each SCSI product does, and the level at which each SCSI product functions. Incorporating these features, the SCSI product listing contains the product category, the supplier, the price, the description, and the SCSI support level for each product. Additional information on SCSI suppliers includes addresses, phone numbers, and technical contacts, as well as cross references to their listed SCSI products. $295.

Technology Forums, 3425 Pomona Blvd, Suite F, Pomona, CA 91768.

INQUIRE DIRECT

Applications information for data communications

This catalog establishes the applications that are appropriate for Series II and Bump protocol-conversion hardware. The publication lists the types of devices and protocols that the hardware and firmware connects to and covers such modes of communication as LANs and X.25 satellites.

Datagraf Inc, 8305 Highway 71 West, Austin, TX 78735.

Circle No 562

Source of data on the microcomputer industry

The Personal Computer—An Industry Source Book includes more than 10,000 company profiles and lists more than 22,000 executives directly involved in the microcomputer industry. Containing more than 1200 pages, the loose-leaf-bound book breaks the microcomputer sector into 16 component parts and arranges company entries alphabetically within each particular area of manufacturing emphasis. Each company listing includes sales volume, year begun, number of employees, type of entity, key contacts, machine specialization, industry specialization, geographic coverage, channels of distribution, and product-line descriptions. In addition, this year's edition of the source book includes a section on the top 5000 computer dealers in the US. $495.

The Personal Computer—An Industry Source Book, Box 3249, Walnut Creek, CA 94598.

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CIRCLE NO 51

Data-acquisition and control catalog

Data Acquisition & Control Catalog & Buyer's Guide contains a how-to section on available systems. In addition to detailing the firm's products, it also shows you how to determine whether a lab automation system would be helpful, which capabilities you should consider when designing a data-acquisition system, and how to choose among the many software packages on the market.

Keithley Instruments Inc, Data Acquisition & Control Div, 28775 Aurora Rd, Cleveland, OH 44139.

Circle No 564

Computer front end and software brochure

A 4-pg, 4-color brochure describes the firm's Helios-I computer front end and its accompanying Labtech Notebook software. The flyer contains information on both the capabilities of the computer and the power of the software.

John Fluke Manufacturing Co Inc, Box C9090, Everett, WA 98206.

Circle No 565

Application note for low-cost MIL-STD 1553 testing

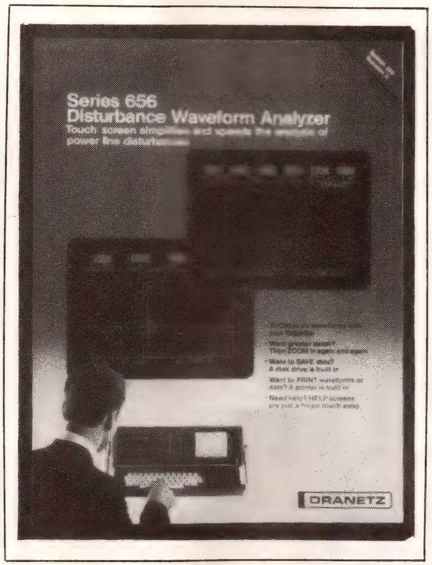
A 4-pg application note (AN/B-11) details how to use low-cost, general-purpose MIL-STD-1553 equipment. The test plan in the note follows the Society of Automotive Engineers proposed RTU Production Test Plan. The note is three-hole punched for loose-leaf binding.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 568

Bulletin illuminates disturbance analysis

A 6-pg bulletin describes in detail how you can monitor and analyze disturbances on power lines with the firm's Series 656 Disturbance Waveform Analyzer. A fold-out page takes you on a tour of the instrument.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Dranetz Technologies Inc, 1000 New Durham Rd, Edison, NJ 08818.

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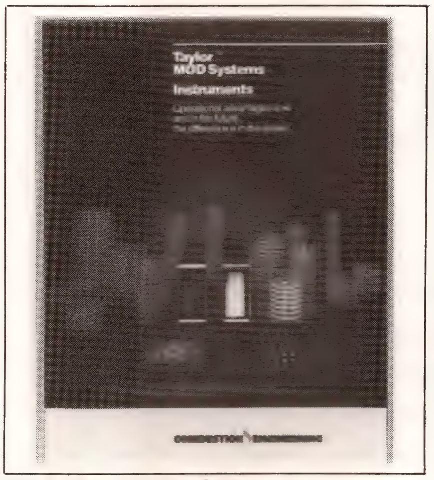

Brochure explains industrial control systems

An 18-pg brochure tells you how to expand an industrial control system based on the firm's MOD Systems Instruments. The booklet contains 4-color photographs and illustrations with detailed technical explanations about the system, which comprises industrially hardened sensors, controllers, and computer interfaces.

Combustion Engineering Inc, 400 West Ave, Rochester, NY 14611.

Circle No 572

RS-232C or IEEE-488 to binary conversion chart

One side of a chart has an ASCII table that you can use to convert between binary or hex and ASCII characters for character-oriented protocols such as RS-232C or IEEE-488. The other side of the chart carries a diagram of the manufacturer's line of data-acquisition products for the IBM PC. In addition to the full-size, 8½×11-in. chart, you get a small pocket-sized version.

Connecticut microComputer Inc, Box 186, Brookfield, CT 06804.

Circle No 567

Test-equipment guide

This 40-pg guide contains specifications, descriptions, photos, and other technical data on this rental firm's line of data-processing and telecommunications test equipment. Listed for rent, lease, or sale are cable-fault-location, microwave, signaling, noise-loading, carrier, and traffic test equipment, and microcomputers, printers, and modems.

United States Instrument Rentals Inc, 2988 Campus Dr, San Mateo, CA 94403.

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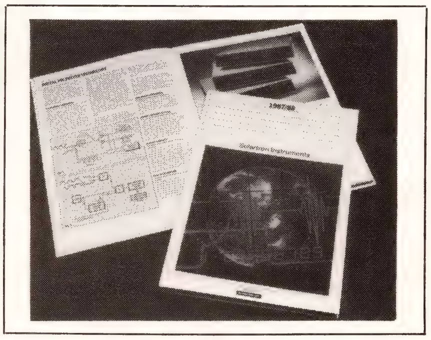

Catalog details test and measuring instruments

This 160-page hardcover catalog details the company's full range of test and measurement instrumentation. Details are provided of more than 80 products that suit applications ranging from precision dc-voltage measurement to optical fiber measurements. The products in the catalog are divided into three broad areas

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TURN TO
PAGE 288

according to their common measurement technology. Each section is prefaced by a discussion of the measurement technology, its history, and its latest developments. Measurement accuracy, calibration requirements, and systems compatibility are also discussed. Full specifications are included for voltmeters, multimeters, data-acquisition and dynamic-analysis equipment, radio communications test sets, telecommunications equipment, logic analyzers, oscilloscopes, frequency counters, function generators, and recorders.

Solartron Instruments, Victoria Rd, Farnborough, Hampshire GU14 7PW, UK.

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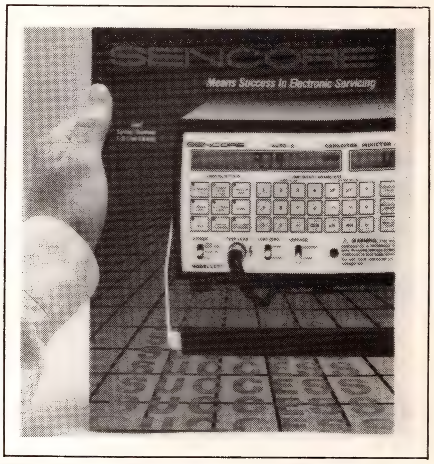


Test-equipment catalog

The latest spring/summer 1987 catalog contains information on video, audio, component, cable, and waveform analyzers and accessories. In addition to complete specifications for all products, the catalog presents applications information.

Sencore Inc, 3200 Sencore Dr, Sioux Falls, SD 57107.

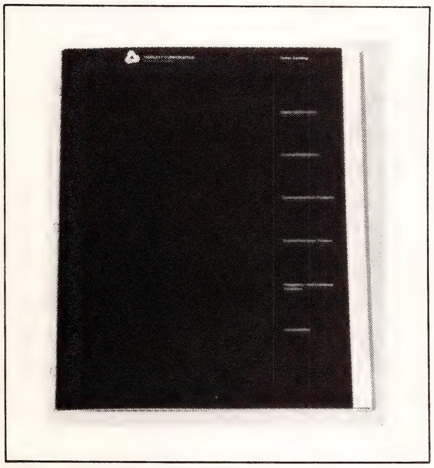
Circle No 573

Catalog of panel-meter and test-equipment

The 64-pg Blue Book is a full-line catalog describing more than 2000 models of digital panel meters and battery-operated portable test instruments. The catalog also contains a glossary of terms and a brief description of the company's history.

Non-Linear Systems, Div of Kaypro Corp, 533 Stevens Ave, Solana Beach, CA 92075.

Circle No 570



Test-equipment catalog

Targeted for industrial, utility, military, and consumer-products engineers, this 48-pg catalog contains six sections detailing the firm's multimeters, communications products, counters, and special-feature testers. Easy-to-use charts provide model-to-model comparisons.

Triplett Corp, 1 Triplett Dr, Bluffton, OH 45817.

Circle No 571

Catalog details measuring equipment

The 12 sections of the 472-pg *Measuring Equipment 1987* catalog detail the company's entire range of measuring equipment. The first section deals with automated testing, and the following sections cover AF and RF signal generators, radiotelephone test assemblies, sweep generators/sweep testers and network analyzers, logic test equipment, voltmeters and power meters, test receivers and analyzers, standard frequency and time systems, recorders, sound level meters, and power supplies. An appendix presents a selection of measurement-related equipment from the company's broadcasting, radio-communications and radio-monitoring divisions.

Rohde & Schwarz GmbH, Muhldorfstrasse 15, 8000 Munich 80, West Germany.

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Data on CAD/CAE software

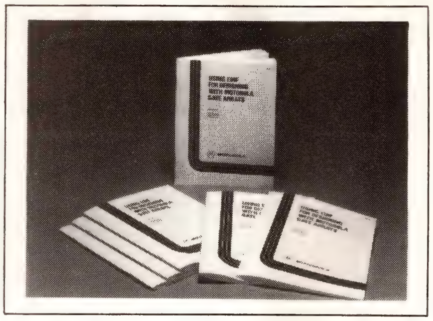
This brochure, which includes data sheets, describes the vendor's line of low-cost CAD/CAE software for personal computers. The document highlights Draftsman EE, a graphics editor for schematic capture and pc-board design; DC/Check+, a package of routing tools that includes a design-rules checker; and DC/Autorouter II, a 1-mil-diagonal autorouter.

Design Computation Inc, 10 Frederick Ave, Neptune, NJ 07753.

Circle No 352

Guide for EDIF users

Using EDIF For Designing With Motorola Gate Arrays (BR357/D) is a functional-specification and user guide for the first version of the company's software using the Electronic Design Interchange Format (EDIF). It describes the information that the company will supply in an EDIF-based ASIC library and the information it needs to build an ASIC device specified by an EDIF file.



Motorola, Literature Distribution Ctr, 616 W 24th St, Tempe, AZ 85282.

Circle No 351

CAE newsletter

The CASE Report, a monthly newsletter, provides you with a view of computer-aided software engineering (CASE) technology, trends, applications, and events. Articles are written by software-development professionals and recognized industry experts. The report also welcomes contributions from its subscribers.

Nastec, 24681 Northwestern Hwy, Southfield, MI 48075.

Circle No 353

Directory of CAD/CAM suppliers

The CAD/CAM Industry Directory —1987 is a 350-pg volume on 600 worldwide suppliers of CAD/CAM hardware, software, and supporting services. It covers CAD/CAM applications and includes 70 cross-reference listings showing all companies that offer products in each functional category. $295.

Dataquest Inc, 1290 Ridder Park Dr, San Jose, CA 95131.

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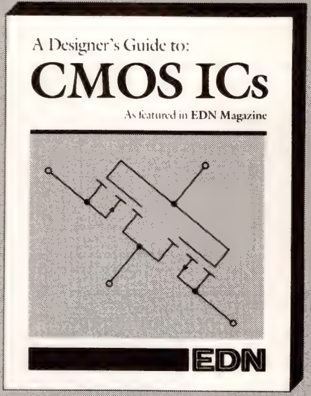

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EDN provides specific "how to" design information that our readers can use immediately. From time to time, EDN's technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

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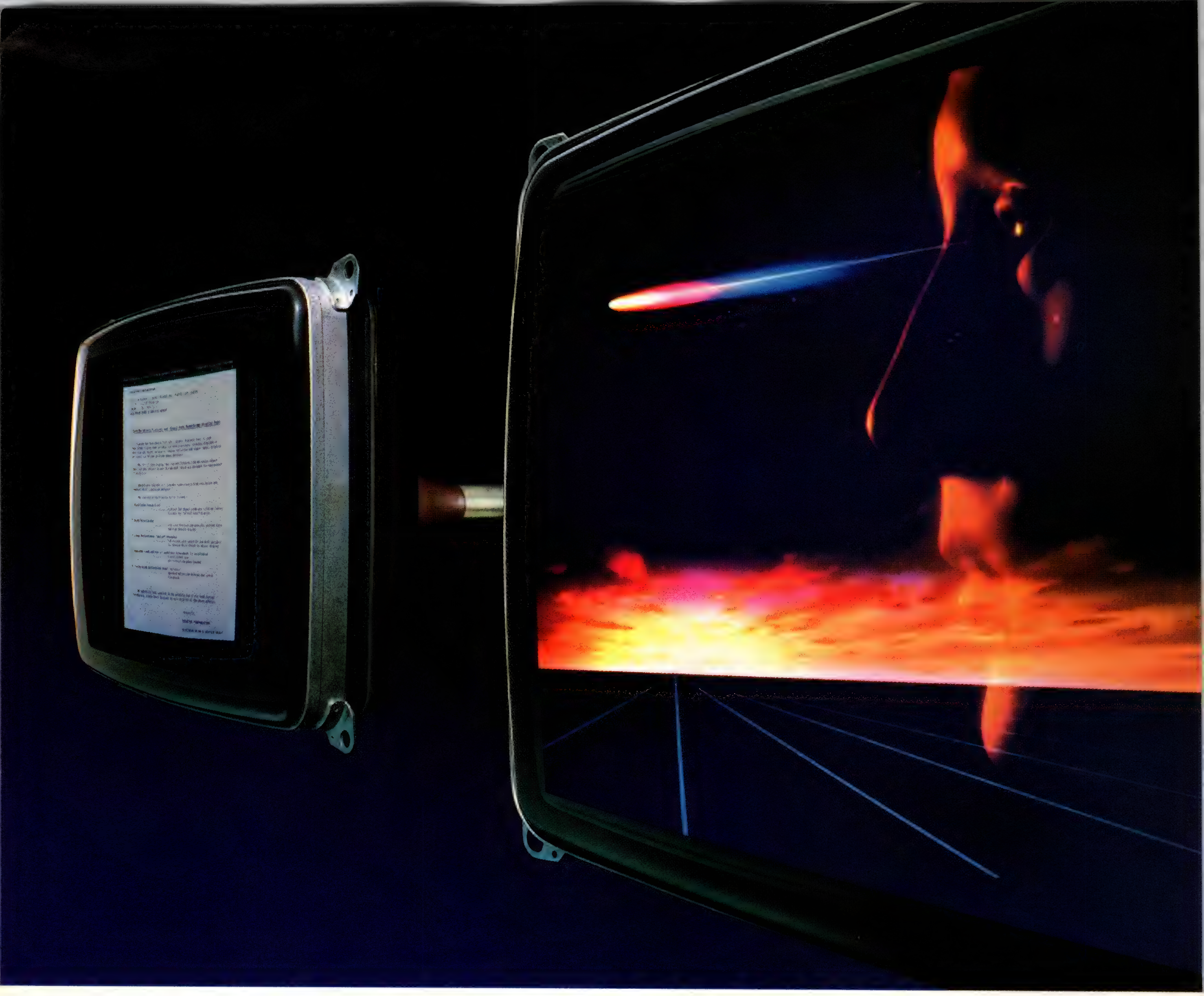

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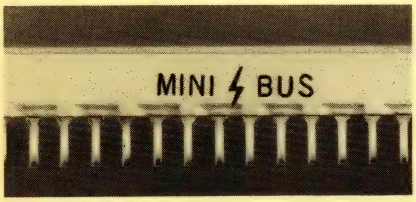

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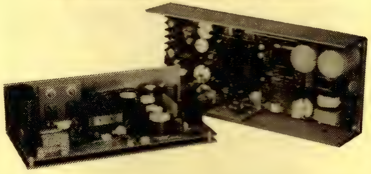

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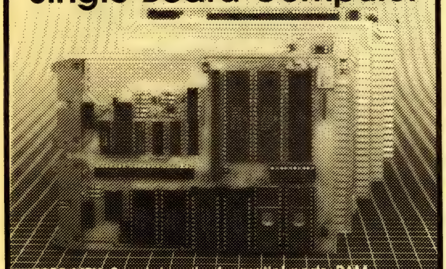

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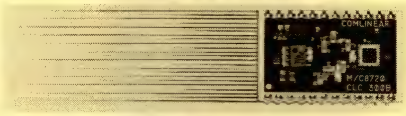

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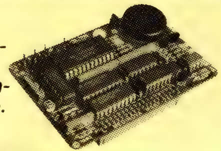

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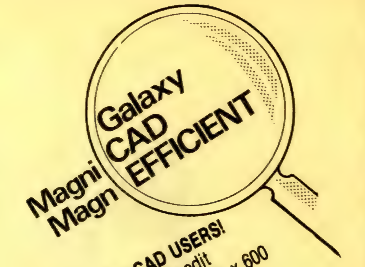

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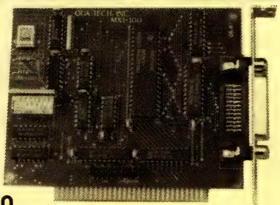

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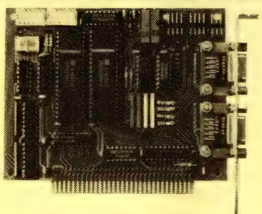

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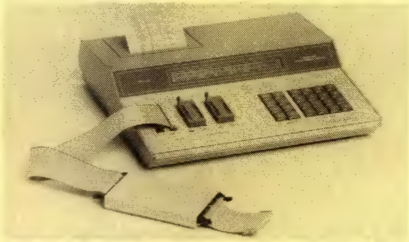

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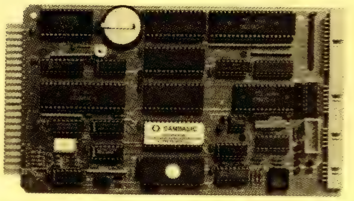

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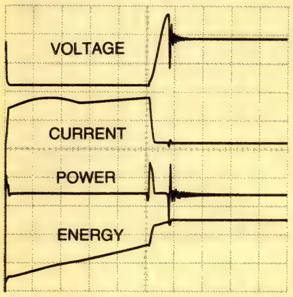

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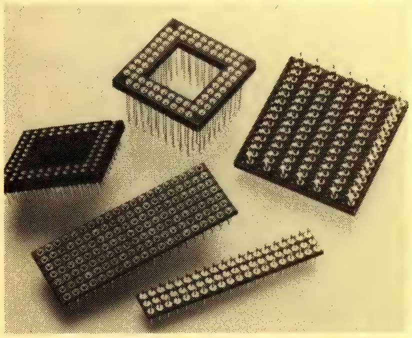

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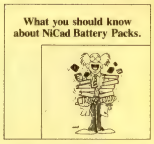

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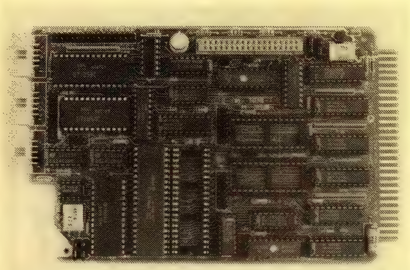

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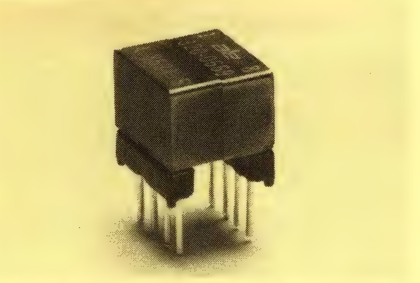

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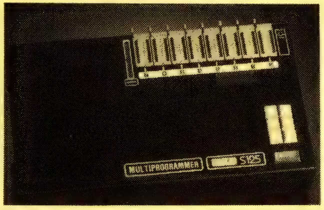

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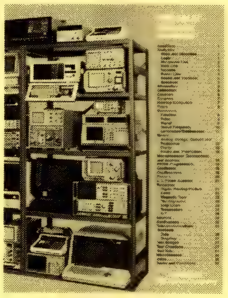

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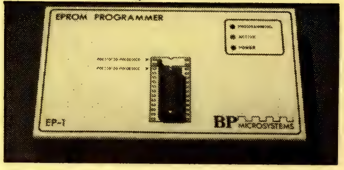

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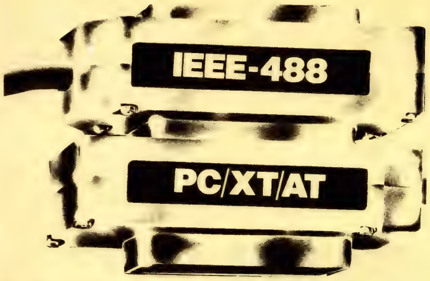

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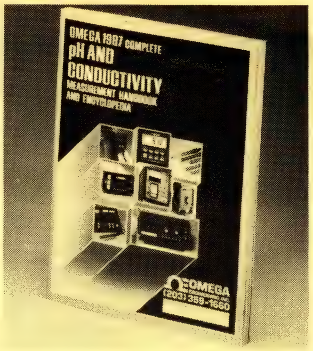

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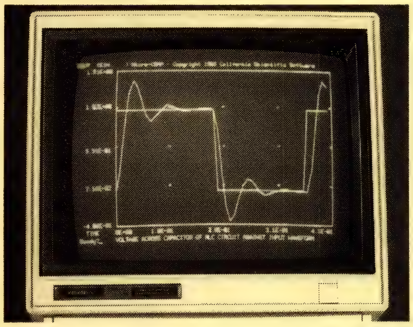

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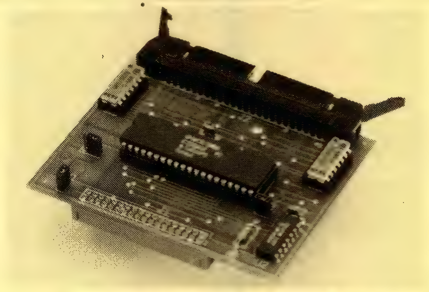

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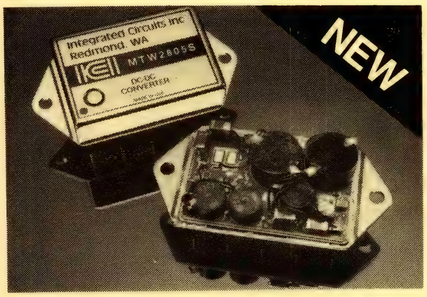

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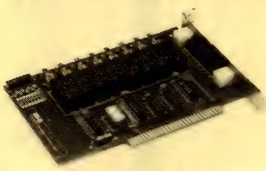

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EDN

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
Aug. 6	July 16	Computer Boards; Digital Signal Processing; Test & Measurement; Top Ten Reader Vote Contest	Closing: July 23 Mailing: Aug. 13
Aug. 20	July 30	Military Electronics Special Issue; Fiberoptics; Software	
Sept. 3	Aug. 13	Analog ICs; CAE; ASICs	Closing: Aug. 20 Mailing: Sept. 10
Sept. 17	Aug. 27	Memory Technology; Communications Technology; Software	
Oct. 1	Sept. 10	Surface-Mount Technology; Computers & Peripherals; Industrial Product Showcase	Closing: Sept. 17 Mailing: Oct. 8
Oct. 15	Sept. 24	Test & Measurement Special Issue; Analog ICs; ASICs	
Oct. 29	Oct. 8	Computers & Peripherals; ICs & Semiconductors; Wescon '87 Product Preview	Closing: Oct. 15 Mailing: Nov. 5
Nov. 12	Oct. 22	Wescon '87 Show Issue; ICs; Computers & Peripherals	
Nov. 26	Nov. 5	Microprocessor Technology Report & Directory; Analog ICs; Sensors & Transducers	Closing: Nov. 12 Mailing: Dec. 3
Dec. 10	Nov. 19	Product Showcase-Volume I; ICs and Semiconductors; Software	
Dec. 24	Dec. 3	Product Showcase-Volume II; Computers & Peripherals; Test & Measurement Instruments	

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Production Design Environment

Product development in a production environment is one of Micron's unique and valuable attributes. Our Research and Development Department employs circuit designers, layout engineers, product engineers and technicians who mutually participate in product development.

The work climate at Micron is characterized by hands-on participation at all levels of the organization. Micron's reputation for innovation in circuit design, quality manufacturing and product reliability is due to the contribution and ideas of our people. And we consider our people to be our most valuable asset.

A Diverse Future

Micron's strategy for the future is to diversify its product line and expand its customer base. Our first steps toward product diversification include 2- and 4-MB memory expansion cards for IBM-compatible PCs. Our next steps will further enhance Micron's reputation for product innovation.

POSITIONS CURRENTLY AVAILABLE

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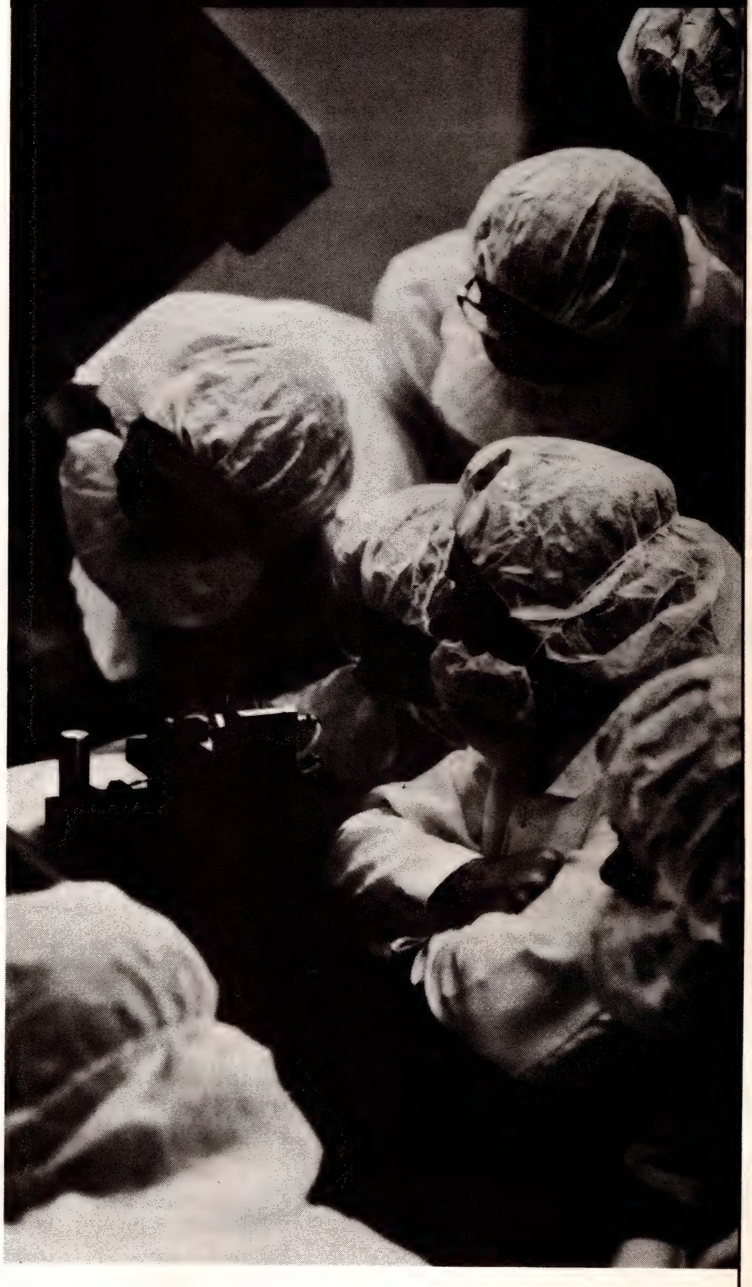

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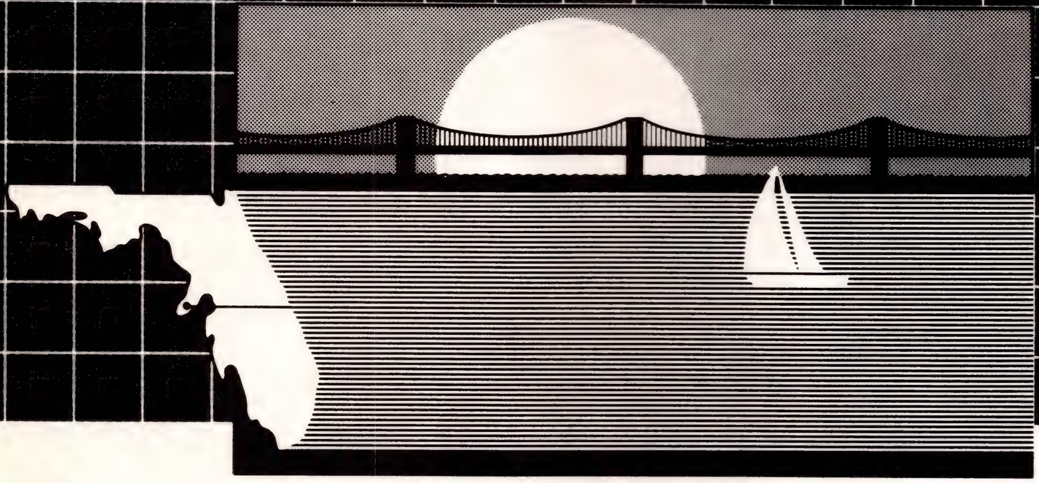

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T-Minus...

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■ **Software Engineers**
For the design, development and implementation of applications, systems and communications software including systems analysis, test and installation.

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■ **Fluids System Engineers**
For the systems and detail design of HVAC, chilled water, compressed gasses, hypergolics, cryogenics, hydraulics, ECS, and vacuum systems.

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■ **Project Engineers**
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■ **Reliability Engineers**
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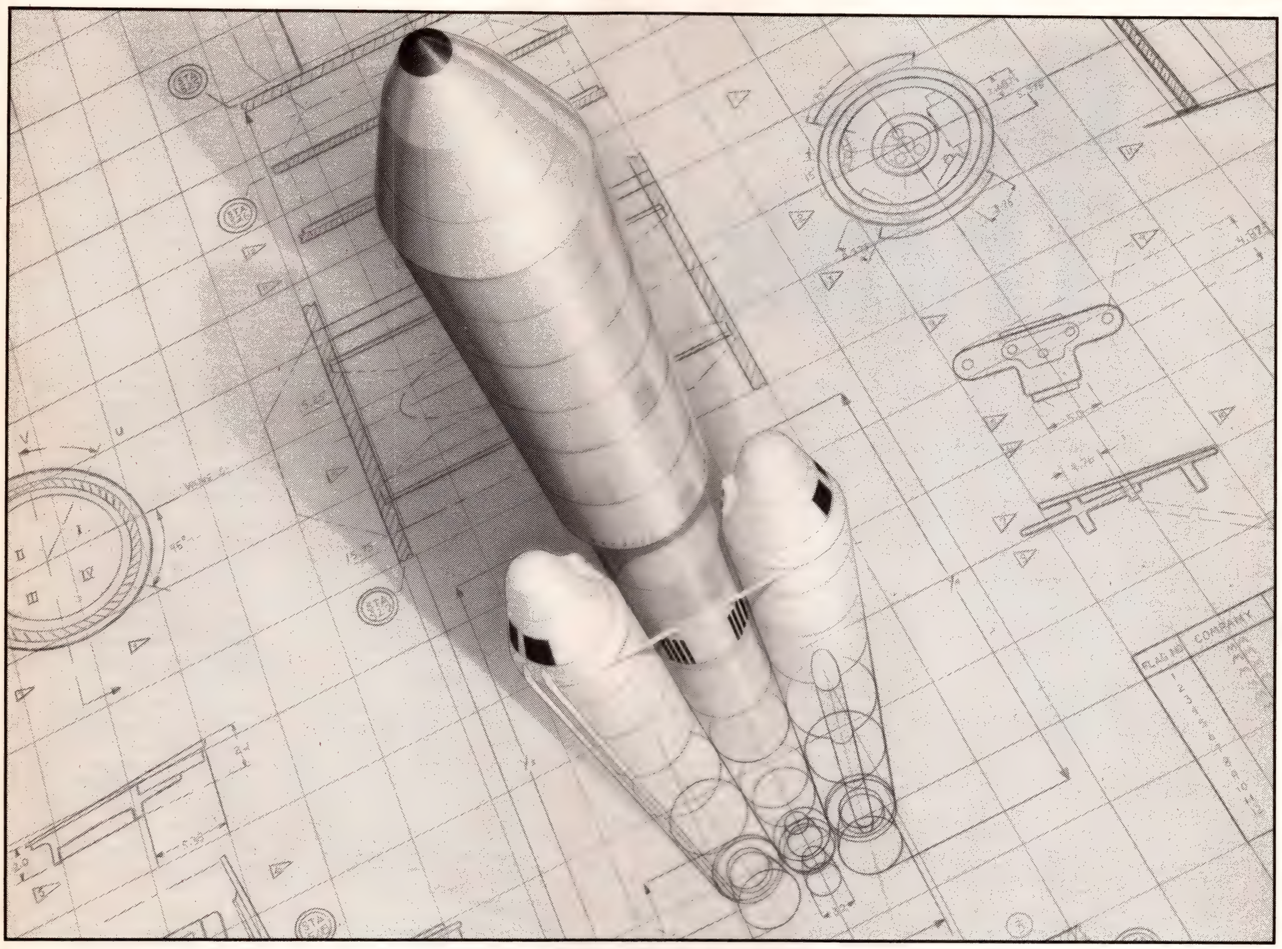

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- Conduct functional and information flow analyses
- Document system-level requirements and specifications
- Develop software requirements for information security, communication and management

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- Design software for information security, communication and management
- Design prototype software
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- Be experienced on VAX or Sun with UNIX and/or VMS, Real-Time applications, and be proficient in MACRO Assembly language

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- Define hardware/software interface and control
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- Identify man-machine interface criteria for terminals and workstations
- Write preliminary design specifications and interface control documents

Communication Systems Engineers

- Develop communication system concepts and requirements
- Design HF, Meteor Burst, UHF, VHF, EHF systems
- Analysis of electromagnetic compatibility
- Design and develop secure voice and telecommunication systems

Hardware Engineers

- Apply hardware solutions for fast text-search and high-density (optical) storage
- Design and implement custom computer-data communication interfaces
- Perform hardware-firmware tradeoff analyses

EMP Engineers

- Harden electronic systems against nuclear electromagnetic pulse
- Have knowledge of circuit interface protection, shielding, grounding and isolation schemes
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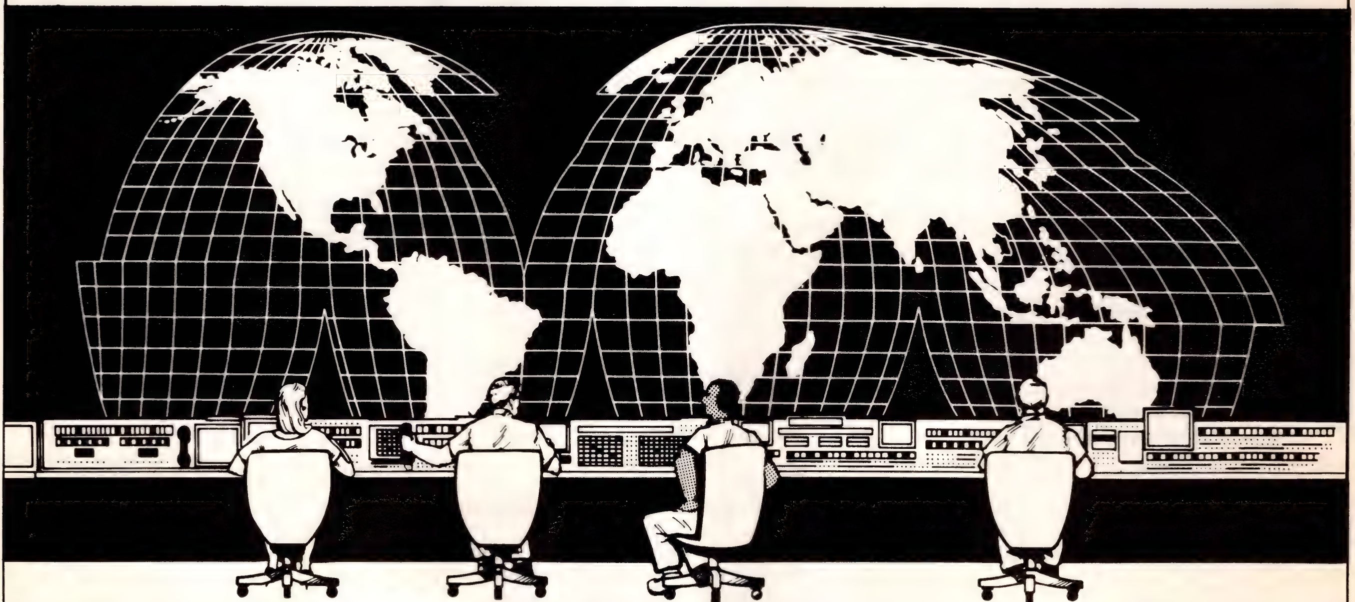

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Transmitter Group

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LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

ESTIMATES AND PROJECTIONS OF LASER AND OPTOELECTRONIC TEST EQUIPMENT MARKET BY PRODUCT—1985 TO 1994 ($M)

TEST EQUIPMENT	1985	1986	1990	1994	AVERAGE ANNUAL GROWTH % 1985 TO 1994
OPTICAL TIME-DOMAIN REFLECTOMETER	33,501	36,820	52,950	75,210	9.4
OPTICAL TEST EQUIPMENT	78,501	85,589	138,124	233,901	12.9
MICROSCOPES	78,980	92,410	175,570	329,350	17.2
SPECTRUM ANALYZERS	85,000	99,800	197,590	371,450	17.8
OPTICAL POWER METERS	10,100	13,100	39,398	118,776	31.5
FIBER-OPTIC TEST EQUIPMENT	4520	6000	19,490	58,580	33
WAVEFORM ANALYZERS	16,500	17,900	24,160	34,400	8.5
DENSITOMETERS	6000	7090	14,660	26,640	18
OTHER	271,538	302,792	476,528	737,963	10.4
TOTAL	584,640	662,320	1,138,470	1,986,270	14.4%

(SOURCE: CORPORATE STRATEGIC INTELLIGENCE)

Laser and F-O test-equipment market to grow at 14.4% rate

The US market for laser and optoelectronic test equipment posted sales of $662 million in 1986. Sales are expected to exceed $1.14 billion in 1990 and approach $2 billion by the year 1994, according to Corporate Strategic Intelligence (CSI) of Middlebush, NJ. These figures represent a 14.4% compound annual growth rate, and CSI sees numerous opportunities for establishing niche markets during this growth period.

Although fiber-optic test equipment represented only 0.9% of the market in 1986, its share of overall sales should more than triple. Growing at an annual compound rate of 33%, the fiber-optic test-equipment segment will have equipment sales of $58.58 million in 1994—2.9% of the market. Spectrum-analyzer sales will increase at a rate of 17.8% and grow from $99.8 million in 1986 to $371.45 million in 1994. Spectrum analyzers will then possess 18.7% of the total market (2 percentage points more than will microscopes). Optical time-domain reflectometers (OTDRs) accounted for 5.6% of the market last year, but CSI predicts their share will drop to 3.8% by 1994. The OTDR business itself, however, will expand moderately.

CSI identifies the major end users of laser and optoelectronic test equipment as academic research laboratories and government agencies, and aerospace, telecommunications, and of course, laser and electro-optics industries. All these segments are expected to grow at average rates, from 13.8% to 16.4%, through the end of 1994. In CSI's analysis, the major end users account for 86% of all sales. Medical devices, industrial process control, and test and measurement lead the minor end users.

$1.5B sales of US relays predicted by 1991

Sales of US relays, valued at just over $958 million in 1986, are expected to reach $1.5 billion by 1991, predicts Venture Development Corp (Natick, MA). The management-consulting company found that, although some sources estimate as many as 120 business segments, a mere 11 segments account for 89.7% of all US relay purchases. Those segments are the military, industrial controls, telecommunications, computer and peripherals, automatic test equipment, office equipment, automotive, instrumentation, security, communications, and appliance businesses.

The military, which uses electromechanical, solid-state, and hybrid relays, purchases the largest share —27% in 1986. This segment also spent the greatest amount on electromechanical relays (TO-5 and crystal).

The industrial-controls business segment purchases all types of relays and ranks second with a market share of 19.8%. Some typical applications are valve, pump, and motor control; factory automation; process control; high-voltage ac; and elevators. VDC predicts that control-equipment manufacturers' demand for general-purpose solid-state relays, I/O modules, and pc-board general-purpose electromechanical relays will increase at above-average annual rates during the next five years. The continuing efforts of manufacturers to automate their processes both at home and abroad will contribute heavily to the higher rates.

Telecommunications claims the third position in relay purchases, and its share of the market, 13.4% in 1986, should grow dramatically over the course of the forecast period. In addition to general-purpose electromechanical and power relays, expenditures for pc-board general-purpose relays, reed relays, and general-purpose solid-state relays will account for the above-average rate increase in this instance.

Computer and peripherals makers now claim fourth position with 5.5% of relay purchases in the US. Although these manufacturers will increase their consumption steadily, ATE manufacturers will supplant them and claim the fourth-largest share by 1991. Purchases by ATE makers will include reed relays as well as general-purpose electromechanical devices.

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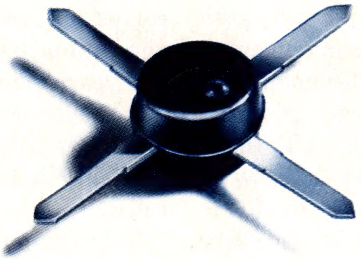

dc to 2000 MHz amplifier series

SPECIFICATIONS

MODEL	FREQ. MHz	GAIN, dB 100 MHz	1000 MHz	2000 MHz	Min. (Note)	MAX. PWR. dBm	NF dB	PRICE $ Ea.	Qty.
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MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

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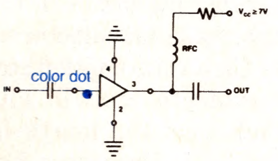

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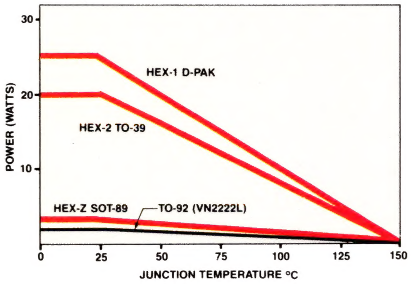

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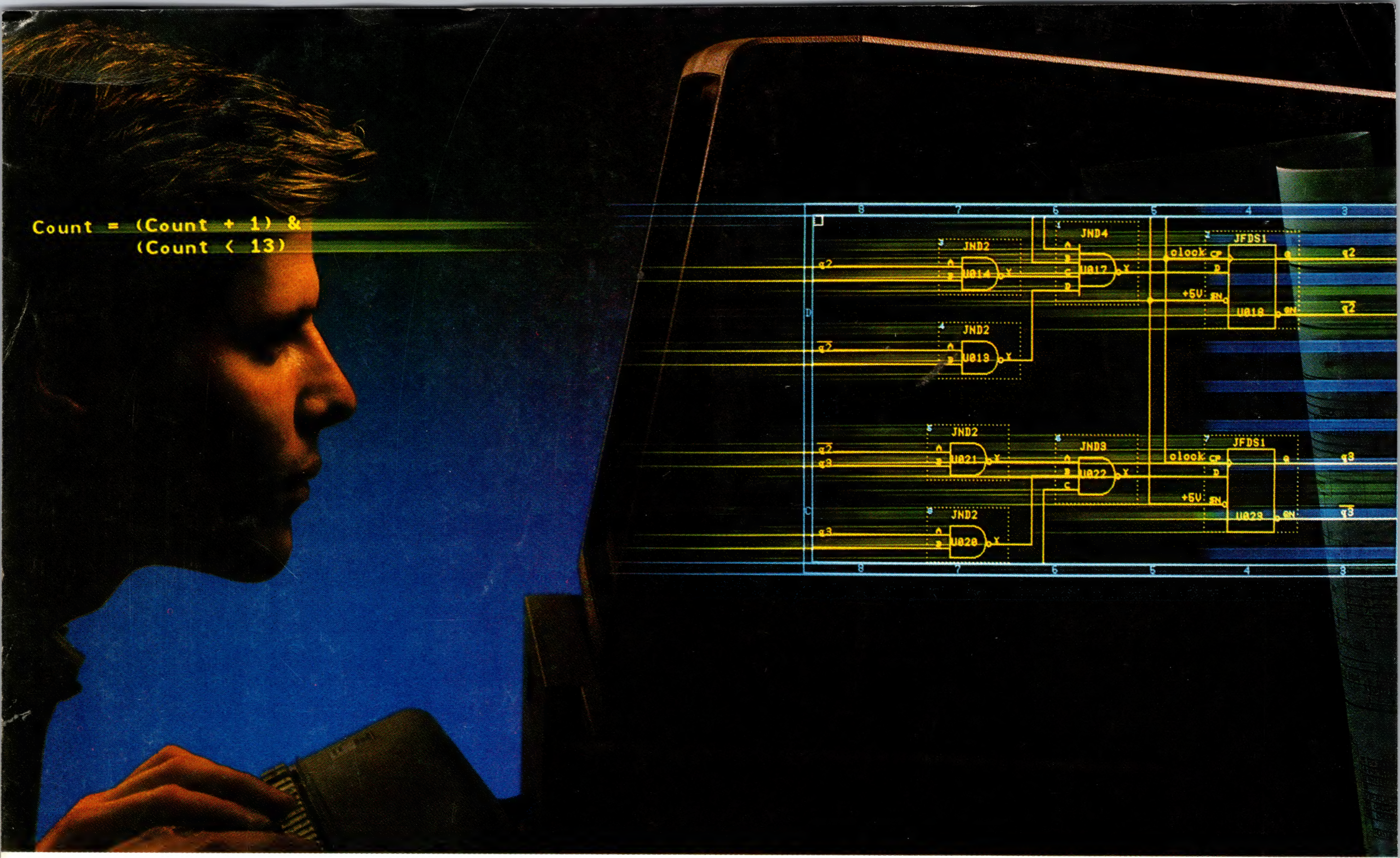

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